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A Semi-monthly Abstract Journal with Indexes

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Office of Scientific and Technical Information

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Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 11 Fluid Mechanics.

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES 1254

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics

04 AIRCRAFT 1255

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

05 ASTRONOMY AND ASTROPHYSICS 1256

Includes: celestial mechanics; and radioastronomy.

For related information see: 12 Geophysics; and 29 Space Sciences.

06 AUXILIARY SYSTEMS 1258

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters.

For primary propulsion systems see: 27 Propulsion.

For related information see: 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; and 22 Navigation and Guidance.

07 CHEMISTRY 1258

Includes: chemical analysis and identification (e.g., spectroscopy); chemical engineering chemical properties of materials; and synthesis.

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Includes: communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation.

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For related information see: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation; and 22 Navigation and Guidance.

09 ELECTRONICS 1266

Includes: circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory.

For related information see: 06 Auxiliary Systems; 08 Communications; 15 Instrumentation; 22 Navigation and Guidance; and 25 Physics, Solid-State.

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10 FACILITIES **1271**

Includes: airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations.

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For related information see: 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

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Includes: ablation; cooling; heating; and other thermal effects.

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For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

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For related information see: 14 Human Behavior; and 28 Space Radiation.

17 MACHINE ELEMENTS AND PROCESSES **1295**

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18 MATERIALS, METALLIC **1298**

Includes: cermets; mechanical and physical properties of alloys and metals; and metallurgy.

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26 **PROPELLANTS AND COMBUSTION** 1317

Includes: fuels; igniters; and oxidizers.

For related information see: 07 Chemistry; and 27 Propulsion.

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28 **SPACE RADIATION** 1335

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Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

For space biology see: 16 Life Sciences.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

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Includes: manned space capsules; satellites; and space probes.

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For launch vehicle–spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

33 STRESSES AND LOADS 1347

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For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 34 Structural Design.

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Includes: structural elements; and weight analysis.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

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Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

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01 GENERAL

Includes: management; space law and legal matters; symposia or conferences of a broad or a general nature.

N63-18236 National Science Foundation, Washington, D.C.
RADIATION EFFECTS IN PHYSICS, CHEMISTRY, AND BIOLOGY. PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS OF RADIATION RESEARCH, HARROGATE, GREAT BRITAIN, AUGUST 5-11, 1962
Michael Ebert and Alma Howard, eds. A book publ. by North-Holland Publ. Co., Amsterdam, 1963 512 p refs
(NASA Grant NsG-186-62)
(NASA CR-50486)

The book is based on a review of 300 papers presented at the International Congress and gives the present and future trends of modern radiation research. It covers (1) physical parameters in radiobiology; (2) radiation chemistry of water; (3) radiation chemistry of macromolecules in vivo and vitro; (4) factors influencing the sensitivity of cells; (5) the linking disciplines in radiation research; (6) chemical protection; (7) radiopathology of mammals; (8) late radiation effects in mammals; (9) biochemical and physiological effects; and (10) ingested isotopes. N.E.A.

N63-18266 California U. Los Alamos Scientific Lab. New Mexico
LAMPRE PROGRAM Quarterly Status Report for Period Ending May 20, 1963
June 25, 1963 19 p
(Contract W-7405-eng-36)
(LAMS-2915) OTS: $0.50

Progress is reported in the Los Alamos molten plutonium reactor equipment program for the period ending May 20, 1963. The LAMPRE I reactor, using core II, accumulated 25.9 megawatt days of operation to give a total power with this core of 96.1 megawatt days. Other projects during this period included: irradiated capsule scanning using a capsule placed in the core to freeze the fuel and fission products in their locations at the time of shutdown; heat-transfer calculations, using the ASTRA heating code, to calculate the relative velocity distribution that would exist in the LAMPRE core sodium channels under laminar flow conditions; the application of two-dimensional transport theory codes to a model of LAMPRE I; a survey of core calculations; new fuel and capsule developments; and research with plutonium alloy systems. D.E.R.

N63-18275 Inter-American Nuclear Energy Commission, Washington, D.C.
4TH INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY, VOLUME II, MEXICO CITY, APRIL 9-13, 1962
Washington, OAS, 1962 236 p 331 refs Abstracts in ENGLISH, SPANISH, and PORTUGUESE

This report represents the second of two volumes of 67 scientific and technical papers presented on the study and investigation of nuclear energy. The papers are presented under: (1) physics, (2) engineering, and (3) geology. N.E.A.

N63-18296 Inter-American Nuclear Energy Commission, Washington, D.C.
4TH INTER-AMERICAN SYMPOSIUM ON THE PEACEFUL APPLICATION OF NUCLEAR ENERGY, VOLUME I, MEXICO CITY, APRIL 9-13, 1962
Washington, OAS, 1962 326 p 367 refs Abstracts in ENGLISH, SPANISH, and PORTUGUESE
OTS: $3.50

This report is the first of two volumes on 67 scientific and technical papers covering peaceful applications for nuclear energy. Major scientific disciplines covered are: (1) physics, (2) engineering, and (3) geology. N.E.A.

N63-18302 Indian Inst. of Science, Bangalore
FIFTY-THIRD ANNUAL REPORT (1961-62) OF THE COUNCIL OF THE INDIAN INSTITUTE OF SCIENCE, BANGALORE 12
Bangalore Press, 1963 393 p 378 refs

A summary of the research and development programs at the Indian Institute of Science is presented. The major fields of research are centered in the biology, chemistry, physics, and engineering departments of the institute. The sponsors of the research program are listed and scholarship requirements are discussed. The income and expenditures of the institute are analyzed, and a staff listing is given. J.L.D.

N63-18314 Midwest Research Inst., Kansas City, Mo.
UTILIZATION OF NASA-GENERATED SPACE TECHNOLOGY BY MIDWESTERN INDUSTRY Quarterly Progress Report No. 2, 5 Feb.-5 May 1962
H. M. Gadberry [1963] 43 p
(NASA Contract NASr-63(03))
(NASA CR-50630) OTS: $4.60 ph, $1.49 mf

The activities of ASTRA (Applied Space Technology Regional Advancement), which markets space oriented ideas of NASA for industrial applications, are described. P.V.E.

N63-18316 Midwest Research Inst., Kansas City, Mo.
UTILIZATION OF NASA-GENERATED SPACE TECHNOLOGY BY MIDWESTERN INDUSTRY Quarterly Progress Report No. 3, 5 May-5 Aug. 1962
H. M. Gadberry [1963] 30 p
(NASA Contract NASr-63(03))
(NASA CR-50648) OTS: $2.60 ph, $1.10 mf

This project is devoted to the application of space technology developed by NASA to technical problems of industrial firms. In this report period, 106 additional followup calls have

been made in Wichita, Joplin, and Oklahoma City, bringing the cumulative total to 140 firms contacted. A contact report is written for each firm visited, indicating the main topics of interest and showing an evaluation of the firm as a potential user of NASA technology. Eight such reports are presented, showing more or less typical response obtained in these calls. As a direct result of these calls on area firms, additional inquiries concerning 275 space-related ideas were received. A distribution of these requests is presented. Case histories of acceptance of NASA technological ideas to put space-derived concepts into commercial use, by 18 firms out of the 140 contacted, are given. N.E.A.

N63-18329 Oak Ridge National Lab., Tenn.
CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1962
F. L. Culler et al Sept. 21, 1963 250 p 195 refs
(Contract W-7405-eng-26)
(ORNL-3314) OTS: $3.50

Some significant developments were as follows: (1) Cold laboratory and engineering development of four processes for uranium- and/or thorium-bearing graphite-base fuels is in progress. (2) A fluoride volatility pilot plant required to scrub the dissolver off-gas with liquid HF was completed, and the system performed excellently in all tests. (3) A pilot plant for the demonstration of the pot calcination process for converting high-activity wastes to solids was carried through the preparation of engineering flowsheets. Chemical and physical performance of the chemical flowsheet developed for final-cycle plutonium purification by tertiary amine extraction was demonstrated in countercurrent runs with simulated feeds and with Purex plant solutions. (4) The solvent extraction process for recovering and separating strontium and mixed rare earths with di(2-ethylhexyl)phosphoric acid was demonstrated successfully in hot cell tests with actual Purex concentrated waste in continuous miniature mixed-settler equipment. P.V.E.

N63-18381 RAND Corp., Santa Monica, Calif.
AMERICAN AND SOVIET INTEREST IN AIRSHIPS
L. S. Hill June 1963 16 p 2 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3698-PR)

The first part of this memorandum deals with two recent *Izvestia* publications on lighter-than-air craft. One is a report of an interview with the head of a newly established Soviet Project and Technical Bureau of Airship Construction in Moscow. The other consists of comments by Soviet officials on the first publication. The last section of this memorandum reviews briefly some current American interest and activity in operational airships. The indication is that, at present, there is no widespread interest in lighter-than-air craft in this country and that airship activity, for all practical purposes, is nil. Author

N63-18508 Cornell U., Ithaca
ABSORPTION SPECTRA AT HIGH TEMPERATURES. I. THE ULTRAVIOLET SPECTRA OF SHOCK-HEATED, *Cis*- AND *Trans*-1,2-DICHLOROETHYLENE
Helen Kiefer (New Mexico U.), N. C. Rol (Haarlam, Netherlands), and S. H. Bauer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 81–89 20 refs (See N63-18501 17-26)
(Contract AF 33(616)-6694)

Absorption spectra were taken of *cis*- and *trans*-1,2-dichloroethylene between 37,000 cm^{-1} and 43,000 cm^{-1}, over the temperature range 800°–1055° K. These gases were highly diluted with argon (97%) and shock-heated. Photographic $[I_\nu(\lambda)]$ and oscilloscope $[I_{\lambda 2537}(t)]$ recordings were made with a resolution of 3–10 μsec. A curve for the ground state electronic energy vs. torsional angle was plotted using the assigned torsional frequencies for the *cis*- and *trans*-forms, and an assumed barrier height of 62 kcal. The large shift toward longer wavelengths observed for the low frequency limits of the continua recorded for both compounds can be qualitatively accounted for as arising from population changes in the upper torsional vibration levels of the ground (N) electric state. A theory is outlined for exploiting such data for the estimation of the shape of the upper (V) state as a function of the angle between the planes of the CCIH planes. Preliminary spectra taken by Dr. Carl Aten of benzene vapor and of perfluorobenzene from about 700° to 1900° K are also presented. For the latter compound, the integrated absorption coefficients change with temperature, as predicted by Albrecht. However, for benzene, the coefficients show a very sharp increase at about 1100° K which cannot be accounted for in this way. This suggests that the B_{2u} state is perturbed by predissociation. Author

N63-18635 Ohio State U. Research Foundation. Inst. for Research in Vision, Columbus
THE VISIBILITY OF NON-UNIFORM TARGET-BACKGROUND COMPLEXES Final Report
H. Richard Blackwell and Gordon A. Bixel Apr. 1963 114 p 24 refs
(Contract AF 30(602)-1974)
(RADC-TDR-63-184)

Experimental studies are reported which involved measuring "detection" thresholds for targets presented against pictorial backgrounds of complexly variable luminance. These studies had three principal objectives. The first was to determine the extent to which it is meaningful to assign a value of "effective contrast" to represent the visibility of a target in a target-background complex in which target and background may be of nonuniform luminance. It was found that effective contrast is a useful concept for a given target-background complex and is generalizable to different exposure durations, probability levels, and background luminances. However, the value of effective contrast must be determined for each individual target, varying in size and luminance, when presented against a background varying complexly in luminance. The second objective was to develop a practical device for determining the value of effective contrast of a given target-background complex. An optical device, the Visual Task Evaluator, was developed for this purpose. The final objective involved a study of the luminance characteristics of target-background complexes affecting their visibility. Three nonuniform backgrounds were used, with targets varying in size, luminance, and placement within the nonuniform backgrounds. Two backgrounds were stylized, whereas the third was a terrain photograph. The general principle was found that, when the background luminance varied within the area occupied by the target, it was the target contrast with the luminance at its border which determined target visibility. Author

N63-18651 National Bureau of Standards, Washington, D.C.
1962 RESEARCH HIGHLIGHTS OF THE NATIONAL BUREAU OF STANDARDS. ANNUAL REPORT, FISCAL YEAR 1962
A. V. Astin Dec. 1962 228 p refs
(*Its* Misc. Publ. 246) GPO: $0.70

Highlights of the research program of the National Bureau of Standards for 1962 are given. The following are covered: (1) physics, electronics, and measurement standards; (2) chemistry and properties of materials; and (3) special technical programs. N.E.A.

02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors and Control Surfaces; and 11 Fluid Mechanics.

N63-18212 Lockheed Missiles and Space Co., Sunnyvale, Calif.
AERODYNAMIC HEAT TRANSFER AND PRESSURE DISTRIBUTION ON BLUNT BODIES AT HYPERSONIC VELOCITIES: AN ANNOTATED BIBLIOGRAPHY [JANUARY 1947-OCTOBER 1962]
Eugene E. Graziano, comp. Dec. 1962 117 p 296 refs
(Contract NOw-63-0050-C)
(SB-62-61)

This bibliography consists of 296 references to sources that contain theoretical and/or experimental data on aerodynamic heat transfer and pressure distribution over blunt bodies at hypersonic speeds. Blunt bodies of all shapes are included. All types of fluids at velocities greater than Mach = 5 were of interest. Materials that otherwise fell within these parameters were excluded if they did not specifically deal with pressure distribution or heat transfer. Author

N63-18328 Naval Ordnance Lab., White Oak, Md.
WIND TUNNEL INVESTIGATION OF THE FORCES AND MOMENTS ACTING ON A CRUCIFORM FINNED MODEL WITH FIXED AND FREELY SPINNING TAIL ASSEMBLIES AT A MACH NUMBER OF 2.0
William E. De Grafft Apr. 8, 1963 22 p 6 refs
(NOLTR-63-79; Aerodynamics Res. Rept.-198)

Spinning cruciform finned models were tested to determine the normal force, pitching moment, side force and yawing moment characteristics at a Mach number of 2.0 and a free-stream Reynolds number of 3.98×10^6 per foot. The models had fin cant angles of 0, 2, and 4 degrees. In addition, the models with the 2- and 4-degree fin cant angles were constructed so that the fin assembly could rotate either with the body as a single unit, or rotate freely with the body locked. The tests showed that for the spin rates developed during the test, the normal force and pitching moments for all models are independent of spin rate and fin cant angle. The yawing moment is reduced, on the average, by a factor of 0.76 if the fins are allowed to rotate freely while the body is held stationary. Author

N63-18356 Aerojet-General Corp. Solid Rocket Plant, Sacramento, Calif.
CORROSION RATES OF REFRACTORY METALS EXPOSED TO NOZZLE COOLANTS [Final Report, Aug. 2, 1961-Jan. 2, 1962]
M. J. Cramer, A. R. Stetson (Solar Aircraft Co.), and G. J. Westcoat Apr. 1, 1962 61 p 2 refs
(Contract NOrd 17017)
(Rept. 397)

This report presents the results of a program to determine the corrosion rates of unalloyed tungsten, tantalum, and molybdenum, and 90% tantalum–10% tungsten alloy, columbium–1% zirconium alloy, and C103 columbium alloy exposed to molten lithium, sodium, potassium, and magnesium. Rectilinear and Arrhenius plots of all systems are presented up to the boiling point of the molten metals at one atmosphere pressure. Data are also presented on the effects of hydrogen chloride gas on the corrosion rate of four refractory metals in an oxygen-hydrogen rocket exhaust. Author

N63-18357 Parke Mathematical Labs., Inc., Carlisle, Mass.
DECODING RULES FOR CERTAIN PRODUCT CODES Scientific Report No. 6
L. Calabi and H. G. Haefeli Mar. 1963 30 p 6 refs
(Contract AF 19(604)-7493)
(AFCRL-63-137)

Decoding procedures are formulated, and their performance established, for products of binary group codes of even minimal weight and for Hobbs' codes of any dimension. Author

N63-18467 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC AERODYNAMIC CHARACTERISTICS OF THREE ROCKET-VEHICLE CONFIGURATIONS AT MACH NUMBERS FROM 1.80 TO 4.63 INCLUDING SOME EFFECTS OF FIN SIZE, FIN CANT, AND AUXILIARY ROCKET MOTORS
Dennis E. Fuller and Gerald V. Foster Washington, NASA, July 1963 52 p 4 refs
(NASA TN D-1929) OTS: $1.50

Wind-tunnel tests were made to determine the effects of fin size, fin cant, and auxiliary rocket motors on two three-stage configurations at Mach numbers from 1.80 to 2.86, and the effects of fin size on one two-stage configuration at Mach numbers from 1.80 to 4.63. All tests were performed at a Reynolds number per foot of 2.5×10^6. The results indicate that, although there is a significant decrease in stability for the two three-stage models in the test Mach-number range, the change in stability level for the model having the same diameter for stages 1 and 2 (model 2) is only about one-half that for the model having stage 2 diameter smaller than that of stage 1 (model 1). In addition, the axial force at an angle-of-attack of 0° for model 2 is considerably lower than that for model 1 at all test Mach numbers. In general, the variation of the static directional-stability derivative (C_{n_β}) with Mach number for a given configuration is essentially the same as the variation of the static longitudinal-stability derivative with Mach number. Canting the vertical fins 2° on model 1 provided roll effectiveness and some increase in C_{n_β} throughout the test Mach-number range. Author

N63-18468 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC STABILITY CHARACTERISTICS OF MODELS OF THE BLUE SCOUT AND THE BLUE SCOUT, JR., RESEARCH VEHICLES AT MACH NUMBERS FROM 2.29 TO 3.75
Lloyd S. Jernell Washington, NASA, July 1963 29 p 4 refs
(NASA TN D-1931) OTS: $0.75

An investigation has been conducted at Mach numbers from 2.29 to 3.75 to determine the static longitudinal and lateral stability characteristics of a 0.067-scale model of the Blue Scout research vehicle, and a 0.10-scale model of the Blue Scout, Jr. The results indicated a slight forward shift in center of pressure with increasing Mach number for both complete models. A small amount of flare-fin interference effect was exhibited by the Blue Scout configuration. Also, an interference between the forward and rearward fins was evident on the Blue Scout, Jr., configurations. Both models indicated a relatively small positive effective dihedral near $\alpha = 0°$; however, at $\alpha = 5°$ the effective dihedral becomes highly negative, especially at the lower test Mach number. Author

N63-18500 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC LOADING CHARACTERISTICS OF A 1/10-SCALE MODEL OF THE THREE-STAGE SCOUT VEHICLE AT MACH NUMBERS FROM 1.57 TO 4.65
Lloyd S. Jernell Washington, NASA, July 1963 37 p 3 refs
(NASA TN D-1930) OTS: $1.00

An investigation has been conducted in the Langley Unitary Plan wind tunnel to determine the aerodynamic loading characteristics of a 1/10-scale model of a three-stage Scout vehicle, at Mach numbers from 1.57 to 4.65. For the angles-of-attack investigated, the data indicate that, in general, the major portion of the normal force is provided by the nose cone and the flared sections. However, for an angle-of-attack of 8°, at Mach numbers of 3.96 and 4.65, most of the normal force is provided by the aft cylindrical section. Author

N63-18717 Boeing Co., Seattle, Wash.
A PARAMETRIC STUDY OF RE-ENTRY WAKES
J. H. Klaimon Oct. 23, 1962 58 p 21 refs
(D2-22040)

This document is the first in a series on the aerothermodynamic properties of hypersonic wakes. The problem of the nonviscous laminar wake, which is characteristic of short blunted bodies at low altitudes, is solved. Related work is now in progress on the effects of the viscous core, the details of the mixing in the base region, and the presence of ablation products and seeding additives in the flow. Author

N63-18720 Advisory Group for Aeronautical Research and Development, Paris (France)
EXAMPLES OF THE USE OF OPTICAL MEASURING TECHNIQUES IN BASIC AERODYNAMIC RESEARCH [EXEMPLES D'APPLICATION DES METHODES DE MESURES OPTIQUES A DES RECHERCHES FONDAMENTALES D'AERODYNAMIQUE]
J. L. Solignac Oct. 1960 46 p 9 refs In FRENCH; ENGLISH Summary Presented at the meeting of the AGARD Fluid Dynamics Working Group on the Industrial Utilization of Wind Tunnels, Oct. 3–8, 1960, Istanbul
(AGARD Rept. 398)

The use of quantitative optical methods (interferometry and interference strioscopy) in aerodynamic research has been investigated in detail. The purpose of this report is to present the essential features of this work, both from the point of view of the apparatus used (the design and development of which are described) and from that of applied research. Some typical results indicate the advantage and the limitations of this particular measuring technique. Author

N63-18749 Aro, Inc., Arnold Air Force Station, Tenn.
VARIABLE RELUCTANCE PRESSURE TRANSDUCER DEVELOPMENT
W. E. Smotherman and W. V. Maddox Arnold Eng. Develop. Center, July 1963 43 p 1 ref
(Contract AF 40(600)-1000)
(AEDC-TDR-63-135)

Pressure transducers whose time response and pressure ranges are suitable for test-section measurements in the hypervelocity tunnels of the von Kármán Gas Dynamics Facility have been developed by the Instrumentation Branch of that facility. A description of these transducers, their theory of operation, and their performance characteristics are presented. Author

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

N63-18234 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
USE OF AERODYNAMIC PARAMETERS FROM NONLINEAR THEORY IN MODIFIED-STRIP-ANALYSIS FLUTTER CALCULATIONS FOR FINITE-SPAN WINGS AT SUPERSONIC SPEEDS
E. Carson Yates, Jr., and Robert M. Bennett Washington, NASA, July 1963 39 p 20 refs
(NASA TN D-1824) OTS: $1.00

The flutter characteristics for two untapered wings, one having 15° sweep and aspect ratio 5.34, the other having 30° sweep and aspect ratio 4.16, have been investigated analytically for Mach numbers up to 3.0. The calculations were based on the modified-strip-analysis method of NACA Research Memorandum L57L10, with the required aerodynamic parameters computed from linear theory, from shock-expansion theory, and from Busemann second-order theory. The results were compared with flutter experiments over the Mach-number range. Supersonic flutter speeds were satisfactorily predicted by the modified strip analysis, employing aerodynamic parameters computed from the nonlinear theories, but were high when supersonic linear theory was used. Flutter speeds calculated for subsonic Mach numbers by use of linear-theory aerodynamic parameters were in good agreement with experimental values. Author

N63-18332 Technology Inc., Dayton, Ohio
WIND TUNNEL STUDY OF PARACHUTE CLUSTERING [Final Report]
J. F. Braun and W. B. Walcott Wright-Patterson AFB, Ohio, Flight Accessories Lab., Apr. 1963 99 p
(Contract AF 33(657)-7985)
(ASD-TDR-63-159)

Four types of canopies were tested in a 12-foot vertical wind tunnel at a velocity of approximately 100 feet per second to determine the static stability and drag characteristics of multiple canopies in various clustered arrangements under captive and equilibrium test conditions. Solid Flat Circular, Extended Skirt, Ringslot, and Circular Flat Ribbon were the types of canopy tested. Canopies of each type were tested individually and in clusters ranging from two to seven canopies per cluster. A special two-component balance was fabricated to measure the pitching moment and tangential force over an angle-of-attack range of ±25 degrees. The effects of riser length, angle-of-attack, reefing ratio, and the number of canopies in a cluster on the tangential force and static stability are discussed. Also, the characteristics peculiar to the solid type of canopies (Solid Flat Circular and Extended Skirt) and to the ribbon type of canopies (Ringslot and Circular Flat Ribbon) are noted. Author

N63-18485 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
A NEW HORN ANTENNA WITH SUPPRESSED SIDELOBES AND EQUAL BEAMWIDTHS
P. D. Potter Feb. 25, 1963 21 p 19 refs
(NASA Contract NAS7-100)
(NASA CR-50625; JPL-TR-32-354) OTS: $2.60 ph, $0.83 mf

For many years pyramidal and conical horns have been used at UHF and microwave frequencies for applications requiring a simple type of antenna with medium gain. In this report a technique is presented for excitation of horns which simultaneously results in complete beamwidth equalization in all planes, complete phase center coincidence, and at least 30-db sidelobe suppression in the electric plane. An analysis of the theory of this technique is presented, together with complete experimental data. Author

N63-18499 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INVESTIGATION OF A SEMISPAN TILTING-PROPELLER CONFIGURATION AND EFFECTS OF RATIO OF WING CHORD TO PROPELLER DIAMETER ON SEVERAL SMALL-CHORD TILTING-WING CONFIGURATIONS AT TRANSITION SPEEDS

Kenneth P. Spreemann Washington, NASA, July 1963 32 p 6 refs

(NASA TN-D-1815) OTS: $1.00

An investigation of the effects of changes in the ratio of wing chord to propeller diameter of three tilting-wing and tilting-propeller VTOL models has been conducted in the 17-foot test section of the Langley 300-mph 7- by 10-foot tunnel. The models had wing-chord–propeller-diameter ratios of 0.333, 0.208, and 0.125, with a single propeller 2.00 feet in diameter located at the wing tips. The investigation indicated that reductions in the ratio of wing chord to propeller diameter made small changes in lift, drag, and pitching moment; this indicates that, with the small ratios of wing chord to propeller diameter in this investigation, these configurations would realize small aerodynamic forces and moments in comparison with those realized from direct propeller thrust. The data are used in an analysis in which a full-scale aircraft is assumed to be in steady level flight. Author

N63-18666 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF FABRICATION-TYPE SURFACE ROUGHNESS ON TRANSITION ON OGIVE-CYLINDER MODELS AT MACH NUMBERS OF 1.61 AND 2.01

Paul W. Howard and K. R. Czarnecki Washington, NASA, July 1963 49 p 4 refs

(NASA TN D-1933) OTS: $1.25

An investigation has been made at Mach numbers of 1.61 and 2.01 over a range of free-stream Reynolds number per foot from about 0.5×10^6 to 4.5×10^6 to determine the effects of fabrication-type surface roughness on boundary-layer transition. Twelve types of surface roughness, including step, wave, crease, waffle, hemstitching, and swept configurations, were investigated. The tests were made on an ogive-cylinder body of fineness ratio 12.2, the roughness elements covering the cylindrical portion of the model. The results indicate that there was little or no difference in transition characteristics for the hemstitching and smooth-waffle type of surface roughness. For most of the other types of roughness configurations, surface roughness decreases the transition distance by approximately a constant percentage over the test Reynolds number per foot range. Transition distance decreases nearly linearly with roughness height for two-dimensional, protruding, unswept type of surface roughness. Generally, roughness shape has relatively small effects on transition, and Mach number has a small favorable effect. Sweptback type of surface roughness appears to have a larger detrimental effect on transition than the transverse or unswept type. Author

N63-18667 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SPEED INVESTIGATION OF CABLE TENSION AND AERODYNAMIC CHARACTERISTICS OF A PARAWING AND SPACECRAFT COMBINATION

William C. Sleeman, Jr. Washington, NASA, July 1963 60 p 9 refs

(NASA TN D-1937) OTS: $1.50

A low-speed investigation was made to obtain detailed information on longitudinal aerodynamic characteristics and cable tension loads for a parawing and spacecraft configuration. The 55° swept parawing represented an inflated-tube structure capable of being packaged in the spacecraft and of being deployed for glide and flared landing recovery of the spacecraft. Three basic cable riggings were studied in order to simulate a glide configuration, a dive configuration, and a landing configuration. Tests were conducted over a range of dynamic pressure from 4 to 14 pounds per square foot for the glide and flare configurations at the design angle of attack for each configuration. Tests were also made over an angle-of-attack range above and below the design condition for all the configurations. Some of the tests were repeated with the model in an inverted position in order to investigate effects of wing weight. The maximum lift-drag ratio for the complete model was 2.7 and for the wing alone was 3.5. The longitudinal stability for the glide and flare configurations was high at angles of attack near the design angle for each configuration. For angles of attack somewhat below the design point, the diagonal cable became slack and the stability was about neutral. The cable-tension data for the design conditions indicated that approximately half of the total tension in all cables was carried in the cables going to the leading edge and the remaining half was carried in the three cables going to the center keel. Author

04 AIRCRAFT

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

N63-18235 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN ANALYSIS OF VG AND VGH OPERATIONAL DATA FROM A TWIN-ENGINE TURBOPROP TRANSPORT AIRPLANE

Paul A. Hunter and Walter G. Walker Washington, NASA, July 1963 48 p 10 refs

(NASA TN D-1925) OTS: $1.25

An analysis has been made of operational data obtained with NASA VGH recorders from two twin-engine turboprop transport airplanes and with NASA VG recorders from two additional identical aircraft operated by a single airline on short-haul routes in the eastern part of the United States. These data are compared with VG and VGH data from two different types of twin-engine piston transport airplanes. The piston-engine operations, although similar to the turboprop operation, covered different geographical locations. In general, the turboprop experienced more severe gust and operational maneuver accelerations than did either of the piston-engine operations. Check-flight maneuver experiences were similar for the three operations. For the turboprop airplanes, the frequency of occurrence and maximum amplitudes of accelerations due to oscillatory

motions were relatively low compared with the gust and maneuver accelerations experienced. Derived gust velocities for the turboprop operations were the most severe of the three operations. Information on airspeed practices indicated no significant differences between the three operations in rough air, the average speed in rough air being generally slightly higher than in smooth air. In contrast to past piston-engine practice, the turboprop exceeded the normal operating limit airspeed in a number of cases. Landing-impact accelerations for the turboprop, following modifications to the landing gear, were approximately 30 percent lower than the initial sample and almost identical to those for a twin-engine piston transport airplane for which data are available. In terms of relative frequency of occurrence, ground-operations accelerations are of primary importance for accelerations less than 0.4g, whereas for magnitudes greater than 0.4g, the landing impacts become of primary importance. Author

N63-18327 David Taylor Model Basin. Aerodynamics Lab., Washington, D.C.
TEST RESULTS OF A TWO-DIMENSIONAL PLENUM CHAMBER GROUND EFFECT MACHINE OVER A LIQUID SURFACE
Anibal Alfredo Tinajero June 1963 80 p 2 refs
(DTMB-AERO-1052)

A two-dimensional plenum-chamber GEM with a trailing-edge flap was tested over a liquid surface. The discharge coefficient was determined for the following parameters: ratio of intake to escape area, ratio of planform area to intake area, hover height, planform loading, flap angle, and distance from the trailing edge of the flap to the liquid. Author

N63-18645 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
A DESIGN AND PERFORMANCE STUDY OF THE NUCLEAR DIRECT-AIR-CYCLE SUPERSONIC AIRPLANE, INCLUDING THE EFFECTS OF OPERATING TEMPERATURES AND FUEL PLATE MATERIAL AND THICKNESS
S. V. Manson and William W. Wachtl Washington, NACA, Mar. 1953 73 p 17 refs
(NACA RM E53C18) OTS: $7.60 ph, $2.39 mf (Declassified)

A study is presented of the effects of high reactor and cycle temperatures, and the effect of thickness of high-temperature fuel-element materials, on the feasibility of the nuclear-powered direct-air-cycle aircraft for flight at Mach number of 1.5, at an altitude of 35,000 feet. Reactor-fuel temperatures from 2060° to 2960° R, turbine-inlet temperatures to 2600° R, and reactor-fuel plate thicknesses of 0.07 and 0.01 inch are covered. The feasibility is expressed in terms of the airplane gross weight and the reactor dimensions required to attain the desired flight performance. The shield thickness and composition are based on a design that allows a crew radiation dosage of one Roentgen per hour. Attention was paid to the internal flow system, component arrangement and weights, external aerodynamics, and, for cases of interest, the reactor fuel-plate thermal stresses and shock. Bases for design and the analytical methods employed for calculation are indicated. Author

N63-18658 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT OPERATING PROBLEMS AND AERODYNAMIC AND PERFORMANCE CHARACTERISTICS OF A FIXED-WING, TILT-DUCT, VTOL RESEARCH AIRCRAFT
Henry L. Kelley and Robert A. Champine Washington, NASA, July 1963 24 p 12 refs
(NASA TN D-1802) OTS: $0.75

The results of a flight investigation conducted at the Langley Research Center are presented. Included are some of the operating problems and related aerodynamic characteristics of a tilt-duct, fixed-wing, vertical-takeoff-and-landing (VTOL) configuration. Buffet-boundary (stall onset) angles of attack, which limited the operational capabilities of this tilt-duct test aircraft, were found to vary considerably over the transition speed range, as well as with power setting. Generally, the stall-free operational range of angles of attack was decreased when operating at reduced power. Simulated ground-controlled landing approaches were investigated at various duct angles and glide-path angles by the use of three methods. The results of one method studied (that of increasing the duct angle by 10° upon intercepting the glide slope) indicated that satisfactory characteristics (handling and flying qualities and pilot work load) were possible with a fixed-wing, tilt-duct fan configuration. When this approach method is used, the duct-angle setting on the glide path was 60° and the airspeed was between 50 knots and 60 knots, depending on the glide angle used. Also presented is an extension of flight-test results in an earlier report which includes stability, control, and performance characteristics recorded over a speed range from 15 to 122 knots which includes duct angles from 80° to 0°. Author

N63-18663 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SOME FLIGHT CHARACTERISTICS OF A DEFLECTED SLIPSTREAM V/STOL AIRCRAFT
Howard L. Turner and Fred J. Drinkwater III Washington, NASA, July 1963 38 p 13 refs
(NASA TN-D-1891) OTS: $1.00

The Ryan VZ-3RY V/STOL test vehicle was flight tested over the airspeed range from 80 knots to below 6 knots. The deflected slipstream concept proved to be better suited to STOL than VTOL operation. Adverse ground effects prevented operation close to the ground at speeds less than 20 knots and below approximately 15 feet altitude. Steep glide slopes to landing (up to −16°) at approximately 40 knots were achieved, but steep, slow, descending flight did not appear feasible. Full-span leading-edge slats markedly increased the descent capability and reduced the minimum level-flight speed. Author

N63-18671 United Air Lines, Inc., Chicago, Ill.
RECOMMENDATION ON DESIGN OF PITOT/STATIC SYSTEMS FOR TRANSPORT AIRCRAFT [Engineering Department Report]
O. E. E. Anderson July 3, 1963 19 p 22 refs
(F-823-B)

Recommendations on the design of future altimeter systems for aircraft, based on the suggestions of airline operators, are presented in a form easily assimilated into aircraft specifications. The altimeter systems recommended are servo-corrected systems which include the best possible static pressure sensors. Three pitot (total pressure) systems, the captain's, copilot's, and an auxiliary, are recommended; and four static systems, the captain's, copilot's, and auxiliary, and an alternate, are planned. D.E.R.

05 ASTRONOMY AND ASTROPHYSICS

Includes: celestial mechanics; and radioastronomy.

For related information see: 12 Geophysics; and 29 Space Sciences.

N63-18278 Harvard Coll. Observatory, Cambridge, Mass.
CLASSIFICATION OF SOLAR PROMINENCES FOR SUNSPOT CYCLE NO. 19-1958 Scientific Report
Donald H. Menzel and F. Shirley Jones Apr. 1963 48 p
(Contract AF 19(604)-4962)
(AFCRL-63-458; Rept. 20)

This report contains a tabulation and analysis of the behavior classification of prominences observed during 1958 at the Sacramento Peak Observatory, Sunspot, New Mexico.
Author

N63-18291 California Inst. of Tech. Div. of Geological Sciences, Pasadena
NEW MEASUREMENTS OF STEEP LUNAR SLOPES
Howard A. Pohn Jan. 7, 1963 4 p Submitted for Publication
(NASA Grant NsG-59-60)
(NASA CR-50096) OTS: $1.10 ph, $0.80 mf

The UBV (ultraviolet blue visual) investigations of the moon from phase angles of −25° to +25°, using the Mount Wilson 60-in. telescope are discussed. A group of 19 craters was selected so as to give a maximum distribution in latitude and longitude. These objects ranged in size from approximately 5 km to more than 90 km. The presence or absence of shadows cast by the interior walls of these craters was noted, over several runs, and the sun's altitude over the object later computed. The sun's altitude is given; it yields directly a minimum value of the steepness of slopes casting a shadow at the time of observation. While some craters were seen to be shadowed over several runs, only the highest sun's altitude is presented. The average value for the observations was 37°.15, and this value includes all of the craters without regard to their selenographic longitudes.
N.E.A.

N63-18292 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DIGITAL COMPUTER APPLICATIONS OF BOSS GENERAL CATALOGUE OF STARS (1950.0) Technical Report No. 5
P. Shapiro Washington, NASA, July 27, 1962 24 p
(NASA TM X-50150; NASA-X-543-62-143) OTS: $2.60 ph, $0.92 mf

A television camera with an 8.3° × 8.3° field-of-view in the OAO (Orbiting Astronomical Observatory) is planned. To help determine the star field that might be presented to a ground observer of the TV screen, the Boss General Catalogue of 33,342 stars has been written on magnetic tape. This report provides a description of the catalog and its uses when star listings are sorted and printed in easily locatable form. Some applications are discussed.
Author

N63-18343 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
LUNAR STRATIGRAPHY
John B. Adams N.Y., Am. Inst. of Aeron. and Astronautics [1963] 10 p 10 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17-20, 1963
(AIAA Paper 63-254) AIAA: $0.50 members, $1.00 nonmembers

The principal processes of stratigraphy on the moon are meteorite impacts, erosion, transportation, and volcanism. Meteorite impacts seem to be the most likely process which will allow age determination. Erosion processes such as seismic shocks, thermal fracture, and solar and cosmic radiation, show little probability of being effective on the moon surface and therefore of little value in the study of lunar stratigraphy. Transportation is, also, an unlikely process because there is still no evidence for the existence of a mechanism to erode or transport lunar surface material. If volcanism does exist on the moon, the overlapping of newer flows on older ones would be an important process in the stratigraphic recording of lunar history.
P.V.E.

N63-18371 RAND Corp., Santa Monica, Calif.
NOTES OF WORKING SYMPOSIUM ON SOLAR SYSTEM CONSTANTS, FEBRUARY 22-26, 1962
Donna Wilson, comp. May 1963 78 p 40 refs
(NASA Contract NASr-21(04))
(NASA CR-50394; RM-3425) OTS: $7.60 ph, $2.54 mf

Topics covered at the Solar System Constants Symposium included the following: philosophies of approach, problem areas relative to the astronomical unit, problem areas of geodetic and geophysical constants, space experiments, earth's equatorial radius, lunar constants, planetary constants, and astronomical unit determinations.
J.A.J.

N63-18373 Chicago U. Enrico Fermi Inst. for Nuclear Studies
DYNAMICAL PROPERTIES OF STELLAR CORONAS AND STELLAR WINDS. II: INTEGRATION OF THE HEAT FLOW EQUATION
E. N. Parker 1963 83 p 24 refs Submitted for Publication
(NASA Grant NsG-96-60)
(NASA CR-50463; EFINS-63-31) OTS: $8.10 ph, $2.69 mf

To illustrate the various asymptotic classes of coronal behavior of stars, other than the sun, so that the position occupied by the solar corona may be seen in its proper perspective, the temperature in a stellar corona is computed under conditions in which energy is supplied outward from the base of the corona only by thermal conduction. The heat flow equation is solved analytically under a variety of different density and temperature conditions. Application of the solutions of the heat flow equation to the sun, assuming that the solar corona is heated solely by thermal conduction, show that the solar corona and wind probably lie in the middle ground between high and low density and temperature.
P.V.E.

N63-18401 Canterbury U., Christchurch (N. Zealand)
THE ANNUAL VARIATION IN THE RADIANT DISTRIBUTION OF SPORADIC METEORS
C. S. L. Keay [1963] 16 p 12 refs Submitted for Publication
(NASA Grant NsG-219-62)
(NASA CR-50416) OTS: $1.60 ph, $0.80 mf

Meteor data obtained from the Southern Hemisphere confirm that the strengths of the helion, apex, and antihelion sources of sporadic meteor activity are in the ratio 2:1:2 when averaged over a whole year. During the year, the helion and antihelion source strengths vary from 0.8 to 4.0 times that of the apex.
Author

N63-18437 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
STUDY OF INTERPLANETARY GAS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 73-75 (See N63-18430 17-32)

A study is made of interplanetary gas which has great significance in explaining the processes of the exchange of gas between an interplanetary medium and the surface layers of the earth's atmosphere. Also, this study aids in understanding the conditions of propagation of the sun's corpuscular radiation. On the basis of data from observations of polarization of zodiacal light, the study of propagation of the so-called whistling atmospherics can be taken as the most accurate model of an interplanetary medium. For experimental verification concerning interplanetary gas in the region of the earth and far beyond its limits, so-called proton catchers were used on cosmic ray rockets.
J.R.C.

N63-18448 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
FIRST PHOTOS OF THE REVERSE SIDE OF THE MOON *In its* Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 159-165 (See N63-18430 17-32)

An analysis of photos of the reverse side of the moon obtained from the Automatic Interplanetary Station (AIS) is presented. As a result of preliminary investigation of available photos, it can be mentioned that on the invisible part of the lunar surface are predominant mountainous regions, and there are very few seas that are similar to the seas on the visible side of the moon. For the most part there are crater seas, lying in the southern and near-equatorial regions. Of the seas photographed on the invisible surface, but close to visible edge, are the Humboldt Sea, Marginal Sea, Smith Sea, and Southern Sea. N.E.A.

N63-18648 McGill U., Montreal (Canada)
THE HYPERVELOCITY IMPACT OF PELLET WITH THIN PLATES: THEORETICAL CONSIDERATIONS, PART 2
D. A. Millar (Computing Devices of Canada, Ltd.), W. H. Friend, C. L. Murphy Oct. 1962 96 p 11 refs
(NASA Contract NAS5-664)
(NASA CR-50706; Rept. 62-8) OTS: $8.60 ph, $3.08 mf

The theoretical analysis of the impact of pellets with thin plates, and the resulting expansion flow are presented in this report. The analysis is based on the impact model in which, what are hoped to be, secondary effects are neglected. The short-term expansion of the plasma, the interaction between shock and rarefaction waves, and the long-term expansion are investigated in some detail. Engineering design data for the protection of a space vehicle from meteor impacts are presented, on the basis of the theoretical calculations carried out on the impact model. Experimental procedures are outlined to check the theoretical results in the velocity range of 7 to 10 km/sec, which are obtainable in the laboratory. Author

06 AUXILIARY SYSTEMS

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters.

For primary propulsion systems see: 27 Propulsion

For related information see: 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; and 22 Navigation and Guidance.

N63-18265 Atomics International, Canoga Park, Calif.
PHASE I MECHANICAL AND THERMOCHEMICAL TEST SERIES: SNAP AEROSPACE SAFETY PROGRAM
S. L. Pfahler June 30, 1963 30 p
(Contract AT(11-1)-GEN-8)
(NAA-SR-8304) OTS: $0.75

This report describes the Phase I Mechanical and Thermochemical Test Series conducted as one of the projects in the SNAP Aerospace Safety Program. The principal objective of the tests was to obtain data and information which could be analyzed for evaluating the hazards that may occur before, during, and after the flight of the SNAP 10A reactor. The results of these tests will provide a means for developing criteria to guide in the design of inherently safe SNAP systems. Author

N63-18457 Temco Electronics, Dallas, Tex.
ENVIRONMENTAL AND RFI TEST PROCEDURE 200 VOLT D.C. MISSILE POWER SUPPLY (INTERELECTRONICS CORP., MODEL 28BF3B-AN-SATURN) Engineering Report
B. L. Nieswiadomy June 15, 1962 60 p 3 refs
(NASA Contract NAS8-1691)
(NASA CR-50392; Rept. 00.360) OTS: $6.60 ph, $2.00 mf

The purpose of this test procedure is to present a detailed plan for the accomplishment of performance evaluation, radio-frequency interference, and environmental testing of a miniaturized, solid-state, missile power supply. Environmental conditions to which the power supply will be subjected are temperature, altitude, vibration, shock, moisture, thermal shock, and acceleration. Author

N63-18581 Lucas Gas Turbine Equipment Ltd., Burnley (Gt. Brit.)
SOME EXPERIENCES IN GAS TURBINE COMBUSTION CHAMBER PRACTICE USING WATER FLOW VISUALIZATION TECHNIQUES
A. E. Clarke, A. J. Gerrard, and L. A. Holliday *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27-Sept. 1, 1962 1963 p 878-891 36 refs (See N63-18501 17-26)

This paper presents a case study using a practical production-type of combustion chamber for an aircraft gas turbine, in which qualitative and quantitative data obtained using the water flow analogy are compared with corresponding data obtained when the chamber was operated under air flow, both isothermally and under combustion conditions, using a gaseous and a liquid fuel. Author

N63-18623 Kaman Aircraft Corp. Kaman Nuclear Div., Colorado Springs, Colo.
INVESTIGATION OF THE FEASIBILITY OF AN AIRCRAFT-OIL ANALYSIS SYSTEM FOR OPERATIONAL USE IN THE FIELD, PHASE I Technical Report [Jan. 26, 1962-May 30, 1962]
Charles W. Whittle and Phillip L. Jessen Ft. Eustis, Va., Army Transportation Res. Command, May 1963 134 p 10 refs
(Contract DA 44-177-TC-789)
(KN-676-1(PR); TCREC-TR-62-91)

Data were gathered from those organizations on the North American Continent which have performed sufficient oil analyses to provide statistically significant information. Metal content of the lubricating oil for Curtiss-Wright Type R-1820-86 piston engines is compared to engine failures. The purpose of the data analysis is to determine whether or not a correlation exists between various metal contents in lubricating oil and failure of the engine. It was found that correlation exists. A survey of methods for the determination of metal content is given. Those methods that appear practical for field use are emphasized. It is concluded that good probability of failure prediction is obtainable if the amount of particular metals is measured for any given engine type. An approximate analysis of the effect of small metal particles in the magnetic field of an inductor indicates that metal concentrations of the order of 100 parts per million will be detectable. Results of the data analysis make it apparent that this metal content may be useful in the prediction of imminent failure; the device would not be sufficiently sensitive for use as maintenance test equipment. Author

07 CHEMISTRY

Includes: chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis.

For related information see: 18 Materials, Metallic; 19 Materials, Non-metallic; and 26 Propellants and Combustion.

N63-18229 Minnesota Mining and Mfg. Co. Central Research Labs., St. Paul

ARCTIC RUBBER [Final Summary] Research Report, Aug. 24, 1960-Dec. 23, 1962

H. A. Brown, N. Knoll, and D. E. Rice [1963] 81 p 14 refs (Contract DA-19-129-QM-1684)

The purpose of this project is the development of chemical-resistant rubbers serviceable at low temperatures (down to -65° F) and chemical-resistant rubbers serviceable at high temperatures (600° F and above) through the investigation and solution of accompanying problems of polymer structure prediction, monomer procurement, synthesis, and purification, as well as polymerization and properties evaluation. A new method of preparing nitrosyl trifluoracetate (and other nitrosyl perfluoroacylates) by the reaction $(CF_3CO)_2O + N_2O_3 \rightarrow 2\ CF_3COONO$ was discovered. It has been found that CF_3NO/C_2F_4 copolymer can be prepared by suspension polymerization techniques. A promising approach to the problem of finding an adequate cure for nitroso rubber appears to be through terpolymerization. Two nitrosoperfluorocarboxylic acids, β-nitrosoperfluoropropionic acid and γ-nitrosoperfluorobutyric acid were prepared by the solid phase photolysis of dinitrosolperfluorosuccinate and dinitrosyl perfluorogluarate, respectively. The carboxyter-polymers could be crosslinked and cured easily with polyvalent metal salts. A study aimed at elucidating the amine cure of perfluoro-nitroso polymers has revealed that n-butyl amine reacts with CF_3NO/C_2F_4 copolymer to give n-butyl amine hydrofluoride, N,N'-dibutyl oxamide and other degradation products. An attempt to render the perfluoronitroso polymers sensitive to radical crosslinking was made by dehalogenating the copolymer of C_2F_4 and $CF_2ClCFClNO$ with zinc in butanol to produce pendant perfluoro vinyl groups. N.E.A.

N63-18233 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

THERMAL DECOMPOSITION OF SOME LINEAR PERFLUOROALKANES IN AN INCONEL BOMB

William L. Fielder Washington, NASA, July 1963 16 p 5 refs (NASA TN D-1744) OTS: $0.50

Perfluoropropane was heated in an Inconel bomb between 663° and 1033° C. Up to about 750° C the products were, essentially, 1 mole of perfluoroethane, some perfluoroisobutene, and some polymeric fluorocarbon per mole of decomposed perfluoropropane. The rates of the decomposition reaction were observed between 670° and 719° C. The rate equation was calculated. Perfluoroethane was heated in the Inconel bomb between 746° and 990° C. Up to 824° C, 2 moles of polymeric fluorocarbon and 1 mole of metal fluoride per mole of decomposed perfluoroethane were produced. The rate equation was calculated from the data observed between 747° and 807° C. Carbon tetrafluoride was heated between 936° and 1090° C. Only a polymeric fluorocarbon and a metal fluoride were obtained. The rates of the decomposition were observed between 930° and 990° C. The rate equation was calculated. Author

N63-18261 RAND Corp., Santa Monica, Calif.

THE LINEAR-LOGARITHMIC PROGRAMMING PROBLEM

R. J. Clasen June 1963 13 p 3 refs (Contract AF 49(638)-700; Proj. RAND) (RM-3707-PR)

The algebraic solution of the linear-logarithmic programing problem, derived by means of Lagrange multipliers, is developed. Two numerical methods for solving the problem are given, one of which is a generalization of a method previously used to solve the chemical equilibrium problem. Convergence has not been proven for either of these methods; however, a number of large chemical equilibrium problems have been solved, using one or both of the methods. Author

N63-18273 Aeronautical Research Labs., Wright-Patterson AFB, Ohio

NATURE OF THE INTERACTION BETWEEN ELECTRONS AND WELL-DEFINED SURFACES: III. ULTRA-HIGH VACUUM SYSTEM AND SAMPLE OUTGASSING IV. GAS SOURCE FOR THE ULTRA-HIGH VACUUM STUDY OF ADSORPTION OF KNOWN-GAS LAYERS ON CLEAN SURFACES

E. L. Kern and A. G. Jackson May 1963 35 p 8 refs (ARL-63-80)

The obtaining and maintaining of atomically clean surfaces is a necessary basic step in the study of well characterized surfaces. The initial part of such cleaning is to incorporate the sample and necessary measuring components in an ultrahigh-vacuum system, capable of maintaining a pressure of $1 \cdot 10^{-9}$ torr (1 torr = 1 mm Hg) to $1 \cdot 10^{-10}$ torr. This report describes the means of obtaining these conditions. A double pumping arrangement, using a diffusion pump and a getter pump, with appropriate vapor trapping, valves, and gages, is described. Chamber bakeout and high-frequency heating of metal components are described. Equipment such as liquid nitrogen and oven controllers, which provide around-the-clock maintenance, is also described. Studies of the influence of known-gas layers on a clean surface necessitate an ultrahigh-vacuum gas manifold system. The vacuum pumping, valving, measuring equipment, and gas manifold are described. Ion gages can be calibrated absolutely against a high-vacuum McLeod gage. By this system, capable of 10^{-9} to 10^{-10} torr, partial pressures of gases of the order of 10^{-12} torr can be introduced into the main testing chamber. Author

N63-18289 Wyandotte Chemical Corp., Mich.

INVESTIGATION OF ACTIVATED SPECIES Summary Report No. 2, Apr. 30, 1962-Apr. 30, 1963

L. E. Kuentzel and R. K. Seizinger Apr. 1963 24 p refs (NASA Contract NASr-24, Amend. 2) (NASA CR-50296) OTS: $2.60 ph, $0.92 mf

This report is largely concerned with the thermal decomposition of diazomethane to form carbene radicals, and their reaction with the radical trapper nitric oxide in an attempt to produce dinitrosomethane. Results currently indicate that the material formed and stabilized at 4° K is a carbodiimide of the following suggested structure: HO-N=C=N-OH. This material apparently polymerizes during warmup to room temperature. Preliminary work on the use of a microwave power generator to produce radicals and activated atoms for these studies is described. The nature of the equipment makes possible experimental attempts to produce activated helium atoms, react them with other activated atoms or groups, and to stabilize any products at 4° K within microseconds of their formation. Author

N63-18295 Brookhaven National Lab., Upton, N.Y.

PROCESS RADIATION DEVELOPMENT. PROGRAM SUMMARIES THIRD ANNUAL CONTRACTORS MEETING HELD AT BROOKHAVEN NATIONAL LABORATORY, UPTON, N.Y., APRIL 22-23, 1963

April 1963 67 p 16 refs (Sponsored by AEC) (BNL-790(C-37)) OTS: $1.75

The Process Radiation Development Program Summaries cover: radiation dosimetry, halogenated compounds, swollen polymers, organic monomers, effect of gamma irradiation on wood, neutron transmutation doping, radioisotopes, and beta radiation as a catalyst for coal to oil synthesis. J.A.J.

N63-18301 Union Carbide Nuclear Co., Oak Ridge, Tenn.
THE VARIABLE KEY WEIGHT CASCADE FOR MULTICOMPONENT ISOTOPE SEPARATION
A. de la Garza July 1, 1963 20 p 5 refs
(Contract W-7405-eng-26)
(K-1571) OTS: $0.50

This report presents a generalization of the previously reported matched-abundance-ratio cascades and constant-key-weight cascades. It is shown how cascades may be formed in such a manner that the key weight is a function of stage number. Application of this result to optimization of a cascade design is very briefly discussed. Author

N63-18347 Radio Corp. of America. Semiconductor and Materials Div., Somerville, N.J.
GALLIUM ARSENIDE EPITAXIAL FILM GROWTH Interim Technical Documentary Progress Report No. 3, Mar. 15, 1963–June 15, 1963
W. Oshinsky June 1963 25 p 3 refs
(Contract AF 33(657)-9179)
(ASD-TR-7-995(III))

A third system intended for the preparation of high-resistivity GaAs was completed and put into operation. Six runs were made with iodine as the halogen transport agent for the gallium. No appreciable growth was obtained. A small amount of Zn was added to the gallium of the trichloride system. Successive runs under identical conditions yielded steadily decreasing hole concentrations, ranging from high $10^{18}/cm^3$ carriers for the first run, down to below $10^{16}/cm^3$ carriers for the seventh run. $ZnCl_2$, at temperatures ranging from 250° C down to 100° C, was used as the dopant. Variation in dopant vapor pressure yielded no commensurate change in hole concentration. Hydrogen sulfide gas diluted with hydrogen was used as n-type dopant. Mixtures in the range 0.01-0.1% H_2S yielded layers which all contained electron concentrations of $4 \times 10^{18}/cm^2$. A technique for making Hall effect and resistivity measurements on epitaxial GaAs layers was developed. The reflectivity method for measuring high carrier concentrations was refined and extended to the range of approximately 5×10^{17} to 10^{19} carriers/cm^3 for n-type material. Author

N63-18353 Monsanto Research Corp., Dayton, Ohio
STUDIES ON THE MECHANISM OF OXIDATION OF POLYPHENYL ETHERS
Glenn R. Wilson, John R. Stemniski, and John O. Smith [1963] 10 p 4 refs Presented at the USAF Aerospace Fluids and Lubricants Conf., Session VI-B, San Antonio, Tex., Apr. 16–19, 1963

The mechanism by which polyphenyl ethers oxidize is elucidated by observing (1) controlled oxidations of polyphenyl ethers, (2) reactions of suspected free radicals with polyphenyl ethers at elevated temperatures, and (3) controlled oxidations of and reactions of free radicals with isotopically-labeled polyphenyl ethers. These observations showed that oxidation reactions resulted in the formation of high molecular weight polyphenyl ethers containing phenyl-phenyl linkages, the abstraction of hydrogen to form phenyl and hydroxyl radicals, and, at a later stage in the oxidation, the intermediates become oxygenated to form new phenyl ether linkages. Reactions of tritium labeled polyphenyl ethers show that the most reactive hydrogens are located on the external rings. P.V.E.

N63-18386 Arkansas U., Fayetteville
NUCLEAR GEOCHEMISTRY Annual Progress Report
P. K. Kuroda et al Jan. 31, 1963 128 p 72 refs
(Contract AT(40-1)-1313)

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6. ISOLATION OF NATURALLY OCCURRING TECHNETIUM B. T. Kenna and P. K. Kuroda Repr. from J. Inor. Nucl. Chem., v. 23, nos. 1–2, 1961 p 142–144 14 refs

N63-18388 Florida State U. Inst. for Space Biosciences, Tallahassee
AMINO ACID COMPOSITIONS OF PROTEINOIDS
Sidney W. Fox, Kaoru Harada, Kenneth R. Woods, and Charles Ray Windsor [1962] 18 p 30 refs Submitted for Publication
(NASA Grant NsG-173-62)
(NASA CR-50418; *Its* Contrib. 8) OTS: $1.60 ph, $0.80 mf

Proteinoids prepared by thermal copolymerization of eighteen common amino acids have been analyzed. Conditions for quantitative recovery of the total amino acids following hydrolysis have been established. The effects of various amino acid reaction mixtures upon the composition of the polymers obtained have been studied. Author

N63-18464 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENTAL STUDIES OF BOWEN'S DECARBONATION SERIES, II. P-T UNIVARIANT EQUILIBRIA OF THE REACTION: FORSTERITE + CALCITE = MONTICELLITE + PERICLASE + CO_2
L. S. Walter Washington, NASA, July 1963 10 p 16 refs
(NASA TN D-1843) OTS: $0.50

The P-T univariant equilibrium curve for reaction A, calcite + forsterite = monticellite + periclase + CO_2, has been experimentally determined to pass through the points: 725° C, 1300 psi_{CO_2}; 850° C, 440 psi_{CO_2} and 925° C, 10,000 psi_{CO_2}. The curve is coincident, within the limits of experimental error, with curves for reactions B and C: 2 calcite + forsterite + diopside = 3 monticellite + $2CO_2$, and calcite + diopside = akermanite + CO_2, respectively. The P_{CO_2}–T field of stability of the assemblage monticellite-forsterite-calcite-CO_2 which lies between the curves for reactions A and B is thus very small. The forsterite-calcite assemblage is usually produced by contact metamorphism by granitic rock types. Equilibrium pressure curves for reaction A are derived. Author

N63-18489 Melpar, Inc., Falls Church, Va.
THE DETECTION OF OXYGEN BY GAS-PHASE POLAROGRAPHY AT LOW TEMPERATURES AND LOW PRESSURES
Gerald Halpert and R. T. Foley [1962] 14 p. 7 refs
(NASA Contract NAS7-100; JPL Contract 950284)
(NASA CR-50605) OTS: $1.60 ph, $0.80 mf

This paper describes an oxygen detector which involves the principle of gas-phase polarography. The oxygen detector described has a capability of operating at low temperatures (to −25° C) and low pressure (10 mm Hg). The sensitivity range is from 0.001% to 100% oxygen. In gas-phase polarography, the diffusion layer is contained by a membrane which is held taut against the microelectrode. The gas diffuses through the special semipermeable membrane and dissolves in the electrolyte. Oxygen in the electrolyte is electrochemically reduced at the polarized cathode in the usual polarographic sense. Except for the membrane-diffusion process, gas-polarography is similar to conventional polarography. Interference species which may affect gas-phase polarography are discussed. N.E.A.

N63-18509 Pennsylvania State U., University Park
SPECTRA OF ALKALI METAL-ORGANIC HALIDE FLAMES
William J. Miller and Howard B. Palmer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 90–95 12 refs (See N63-18501 17-26)
(Contract Nonr-1858(25))

An experimental survey has been made of the emission from flames of a number of halides burning in potassium and sodium vapor. There appear to be no previous reports in the literature of emission from such flames, other than characteristic alkali metal atomic radiation. Results of the present study show that these flames emit, in addition to atomic line spectra, a complex array of molecular band spectra. A continuum is also observed in several of the flames. Interpretation of unusual C_2 excitation in haloform-K systems has produced added evidence for the importance of the reactions, $2CH \rightarrow C + CH \rightarrow C_2 + H$, as a mechanism for producing excited C_2. An analogous interpretation of the C_2 emission in CCl_4-K and -Na flames has yielded evidence supporting the value, $D_{c\text{-}cl} = 51$ kcal, in the CCl radical. Energy transfer processes are important in these flame systems. Although there are several unanswered questions about the spectra, it is felt that these reaction systems may lend themselves to a useful study of electronic and vibrational energy transfer. Author

N63-18510 Israel Inst. of Tech., Haifa
SPECTRAL EMISSIVITY OF THE 4.3 μ CO_2 BAND AT 1200° K
U. P. Oppenheim *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 96–101 20 refs (See N63-18501 17-26)

Under certain conditions, the emission (or absorption) of spectral bands of molecules in the gaseous state may be described with the help of the "statistical" model. The present study deals with application of this model to the 4.3 μ band of CO_2 at a temperature of 1200° K. A simple method was employed for correlating the observed emissivity with the experimental parameters of the gas (pressure, optical depth, etc.). Use was made of curves of growth for every frequency in the band. Experimental emissivities were obtained by heating CO_2 in cells of different length in an electrical furnace. Good quantitative agreement was found with experimental results of other workers. It is shown that Lambert-Beer's law is not obeyed and that the statistical model predicts the emissivity correctly over wide ranges of pressure and optical depth. Author

N63-18515 Safety in Mines Research Establishment, Buxton (Gt. Brit.)
THERMAL DECOMPOSITION OF WOOD IN AN INERT ATMOSPHERE
A. F. Roberts and G. Clough *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 158–166 8 refs (See N63-18501 17-26)

The thermal decomposition of wood has up to now been represented by an overall first-order reaction with a definite heat of reaction. There is now sufficient experimental evidence to show that such a treatment is too simple, since values obtained for activation energy and heat of reaction vary with experimental conditions. The present paper describes a series of experiments in which cylinders of wood were decomposed under controlled heating conditions in an atmosphere of nitrogen in a furnace. During each experiment, the specimen was weighed continuously and its temperature was measured at several points. Data were analyzed in terms of the above theory to examine its validity and shortcomings. Author

N63-18521 Cambridge U. (Gt. Brit.)
RATES OF SOME ATOMIC REACTIONS INVOLVING HYDROGEN AND OXYGEN
M. A. A. Clyne *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N. Y., Aug. 27–Sept. 1, 1962 1963 p 211–219 25 refs (See N63-18501 17-26)

Reactions of ground state oxygen and hydrogen atoms produced by an RF electric discharge were studied in a flow system at pressures of about 1 mm Hg. Hydroxyl radicals and oxygen atoms are generated in the $H + NO_2$ reaction and measurements of the rate of removal of oxygen atoms in this system led to a value for the rate constant k_3 of the rapid reaction. Author

N63-18522 Northern Research and Engineering Corp. London (Gt. Brit.)
KINETICS IN HYDROGEN-AIR FLOW SYSTEMS. I. CALCULATION OF IGNITION DELAYS FOR HYPERSONIC RAMJETS
E. D. Taback and R. F. Buswell (Pratt and Whitney Aircraft) and I. N. Momtchiloff *In* Ninth Symp. (Intern.) on Combust., Cornell U. Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 220–230 25 refs (See N63-18501 17-26)

An analytical method of estimating auto-ignition delay time based on dissociation and recombination rates of gases has been developed. In this analytical method, the one-dimensional gas-dynamics equations are combined with reaction-kinetics equations to formulate a set of $(n + 5)$ simultaneous, nonlinear-first-order differential equations, where n is the number of species considered. These equations describe the behavior of a mixture of reacting gases flowing supersonically down a duct. A computer program has been evolved and used to solve these equations for the particular case of hydrogen-air mixtures. The ignition delay periods obtained through this program are in good agreement with the limited amount of experimental data available for hydrogen and air. Author

N63-18562 Aberdeen Proving Ground. Ballistic Research Labs., Md.
FAST REACTIONS OF OH RADICALS
F. Kaufman and F. P. Del Greco *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 659–668 36 refs (See N63-18501 17-26)

The reversible, bimolecular reactions of OH radicals with OH, H_2, O, and H are discussed. New experimental data for the first three, in their forward direction, near 300° K, are obtained by measuring local OH concentrations in a discharge-flow system of high pumping speed in which the OH is produced by the fast reaction $H + NO_2 \rightarrow OH + NO$. For the reactions $2OH \rightarrow H_2O + O$, $OH + H_2 \rightarrow H_2O + H$, and $OH + O \rightarrow O_2 + H$ we measure rate constants of $1.5 \pm 0.4 \times 10^9$, $4.3 \pm 1.0 \times 10^6$, and $1.1 \pm 0.4 \times 10^{10}$ liter mole $^{-1}$ sec^{-1}. The present status of the thermodynamic quantities $\Delta H°$ and $\Delta F°$ for the four equilibria is summarized, and approximate expressions for the equilibrium constants are presented. Other recent work on these eight reactions is described, and Arrhenius expressions are proposed for all the rate constants. Author

N63-18563 Brown U., Providence, R. I.
A STUDY OF THE REACTION OF POTASSIUM WITH CH_3Br IN CROSSED MOLECULAR BEAMS
M. Ackerman, E. F. Greene, A. L. Moursund, and J. Ross *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 669–677 15 refs (See N63-18501 17-26)
(Supported by AEC)

The reaction $K + CH_3Br \rightarrow KBr + CH_3$ has been studied by measurements on the scattering of a velocity selected K beam by a crossed thermal of CH_3Br. Although KBr could not be detected directly, information about the reaction could be obtained from the measurements of the elastic scattering in the reactive system. An analysis based on the assumption that the interaction of the reactants can be represented by a spherically symmetric potential led to: (1) potential parameters for an assumed analytic form of interaction; (2) the threshold of the reaction cross section, 0.24 kcal/mole; (3) the probability of reaction as a function of relative initial kinetic energy at the distance of closest approach; (4) the energy dependence of the total reaction cross section; and (5) an estimate of the absolute value of the total reaction cross section, 21 $Å^2$, at 1.93 kcal/mole. Author

N63-18564 National Bureau of Standards, Washington, D.C.
ATOMIC FLAME REACTIONS INVOLVING N ATOMS, H ATOMS AND OZONE
D. Garvin and H. P. Broida *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 678–688 29 refs (See N63-18501 17-26)

Although no radiation is observable from the fast exothermic reaction $N + O_3 \rightarrow NO + O_2$, the addition of H atoms produces a flame with ultraviolet and visible emission. The emitters in the flames are OH, NH, NO, N_2 and, under certain conditions, NH_2. The characteristics of this prototype combustion system are: (1) N atoms, H atoms, and O_3 must all be present in the reaction zone. (2) H atoms catalyze the consumption of ozone beyond that expected from $H + O_3 \rightarrow OH + O_2$. (3) NO and NO_2 are not important intermediates. (4) The nitrogen emission (1st positive bands) is not the result of the mechanism operating in the Lewis–Rayleigh nitrogen afterglow. (5) Vibrationally excited OH radicals are important in the mechanism for forming NH and in the excitation of the emitters.

The rate constant for the reaction $N + OH \rightarrow NO + H$ is estimated to be greater than 10^{-11} cc/molecule-second. Author

N63-18565 National Research Council of Canada, Ottawa
A KINETIC STUDY OF HYDROCARBON-OXYGEN-NITROGEN FLAME SYSTEMS AND MOLECULAR WEIGHTS OF CHAIN CARRIERS
W. E. Falconer and A. Van Tiggelen (Louvain U.) *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 689–702 25 refs (See N63-18501 17-26)

On the basis of three experimental properties which have been measured in *n*-butane, isobutane, and neopentane flames in mixtures with oxygen either at different stoichiometric ratios or at different preheating temperatures, two important parameters have been derived: the overall activation energy E_r of the branching process and the mean molecular weight M of the chain carriers in such flames. The results are respectively: *n*-butane: $M = 23$; $E_r = 33$ kcal; isobutane: $M = 24$; $E_r = 31$ kcal; neopentane: $M = 28$; $E_r = 38$ kcal. These results are compared to analogous data obtained previously with other hydrocarbons, and an interesting relation is observed between the bond energy CH and the activation energy of the branching process at least for saturated hydrocarbon compounds. Furthermore, the rather low value of the mean molecular weight of the chain carriers constitutes an argument in favor of a rapid destruction of the alkyl radicals in their reaction with molecular oxygen; no peroxy radicals persist at the higher temperatures of the flame as compared to the temperature in slow oxidations. Author

N63-18569 Stanford Research Inst., Menlo Park, Calif.
HOMOGENEOUS AND HETEROGENEOUS REACTIONS OF FLAME INTERMEDIATES
H. Wise and W. A. Rosser *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 733–746 62 refs (See N63-18501 17-26)
(Supported by Navy; Proj. Squid)

Studies of the homogeneous reaction kinetics of flame intermediates yield a reaction mechanism for the combustion of simple hydrocarbons. On the basis of such a mechanism, the inhibition of flames by halogenated compounds and inorganic salts may be interpreted in terms of the removal of specific chain carriers as a result of: (1) their replacement by halogen atoms which no longer can lead to branching reactions, or (2) their homogeneous recombination catalyzed by alkali atoms. The interaction of free radicals with solid surfaces may result in chemical reaction with the substrate and the formation of a volatile or nonvolatile product, or the reaction with the absorbate. Measurements of the surface-catalyzed recombination of atoms have demonstrated the controlling effect of energy transfer to the solid in such exothermic heterogeneous reactions involving hydrogen or oxygen atoms. In the case of Pyrex glass and quartz, a change in the order of the surface reaction with temperature has been noted. A number of tables are presented which summarize the available information on the catalytic efficiencies of various solids for atom recombination. Author

N63-18570 Yale U., New Haven
INTRODUCTION [TO] COLLOQUIUM ON CHEMICAL REACTIONS AND PHASE CHANGES IN SUPERSONIC FLOW
P. P. Wegener *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 747 (See N63-18501 17-26)

The present state of experimentation and analytical development in gasdynamics and chemical kinetics as applied to supersonic flow is discussed. Emphasis is placed on flow of real gases in converging–diverging nozzles. Also, three additional

aspects of nozzle flow are treated: low temperature and gaseous expansion and the case when the fluid medium is an electrical conductor and moves in the presence of magnetic fields. P.V.E.

N63-18571 California Inst. of Tech., Pasadena
RATE AND RADIATIVE TRANSFER PROCESSES DURING FLOW IN DE LAVAL NOZZLES
S. S. Penner, J. Porter, and R. Kushida (Natl. Eng. Sci. Co.) *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 748–759 35 refs (See N63-18501 17-26)
(Supported by Army and AF)

Some of the important physical ideas that have been used in analyses of chemical changes in rocket nozzles are reviewed, with particular reference to three-body recombination reactions. The conditions are specified under which the near-equilibrium flow criterion developed about 15 years ago leads to results that are substantially equivalent to estimates derived from the criterion of Bray, after the latter has been suitably corrected. The problem of chemical changes during nozzle flow for interdependent, concurrent chemical reactions is examined. An explicit relation is presented for the rate of entropy production. A set of linear algebraic equations is derived for near-equilibrium flow in terms of the logarithm of the dimensionless ratio of the pressure quotient to the corresponding equilibrium constant. Surface-catalyzed processes are likely to be important in determining atomic recombination rates in the nozzles of present-day solid-propellant rocket engines. The influence of radiative energy transfer on the effective thermal conductivity in two-phase nozzle flow (with chemical reactions) has been studied in the diffusion approximation. Author

N63-18572 University of Southern Calif., Los Angeles
ENERGY TRANSFER PROCESSES AND CHEMICAL KINETICS AT HIGH TEMPERATURES
Sidney W. Benson *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 760–769 19 refs (See N63-18501 17-26)
(Supported by NSF and Douglas Aircraft Co.)

Recent theoretical studies of the rates of recombination of atoms in gases are examined and discussed in terms of the experimental evidence available. Unfortunately, most of the latter is of such low precision that many of the fine distinctions cannot be made. It does appear, however, that the recombination process must involve deactivation of nascent molecules by consecutive collisions rather than by large energy transfers. The justification for a consecutive collision process is examined in terms of recent theoretical studies of the vibrational-energy transfer process and shown to be quite strong. These studies yield two independent evidences supporting the belief that vibrational energy exchange occurs as a 1 quantum process for both ground level and highly excited oscillators. Some recent studies on ionization processes in strong shocks are examined briefly, and mechanisms are described for electronic excitation as well as ionization. It is shown that very low values for the ionization activation energy must be accompanied by such low Arrhenius A factors as to make the data implausible. Some general considerations are described governing the process of homogeneous catalysis of recombination at high temperatures, and it is shown that the recombination of H atoms can be accelerated by factors of 100-fold or more by the addition of small amounts ($\sim 1\%$) of suitable molecular species. Author

N63-18573 Southampton U. (Gt. Brit.)
CHEMICAL REACTIONS IN SUPERSONIC NOZZLE FLOWS
K. N. C. Bray *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N. Y., Aug. 27–Sept. 1, 1962 1963 p 770-784 53 refs (See N63-18501 17-26)

Departures from thermochemical equilibrium involve energy withheld from the active degrees of freedom of the gas and may therefore cause a large loss of thrust in propulsive nozzles. Nonequilibrium effects are also important in the use of high-enthalpy wind tunnels, where they may produce a test fluid whose composition and properties are very different from those of equilibrium air. Finally, freezing of the ionization level in a channel-type MHD electrical generator could lead to a useful increase in the d.c. conductivity of the gas. The object of this paper is to provide a summary of the present state of knowledge concerning these problems. Basic assumptions which are made in theoretical studies of nonequilibrium flows are first reviewed. The paper includes a brief survey of published experimental results. It is concluded that two types of experimental data are urgently required; experiments on simple chemical systems to determine rate constants applicable to nozzle flow problems, and experiments on flows where coupled chemical reactions are predicted to play a dominant role. Much effort is being invested in these problems and knowledge is likely to increase rapidly. Author

N63-18574 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.
COMPLEX CHEMICAL KINETICS IN SUPERSONIC NOZZLE FLOW
A. A. Westenberg and S. Favin *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 785–798 25 refs (See N63-18501 17-26)

This paper discusses the many elementary chemical reactions that occur simultaneously in a gas undergoing laminar, steady, adiabatic flow through a supersonic expansion nozzle. Some general comments on the techniques involved in the numerical analysis of this type of nonequilibrium flow with a high-speed digital computer will be given, but the emphasis throughout is on the chemical kinetic aspects of the problem. All internal degrees-of-freedom of the molecules are assumed to be in equilibrium with the local translational temperature everywhere. The flow is taken to be one-dimensional in the usual fluid-dynamic sense. The interaction between chemical and fluid-dynamic variables is illustrated by actual results on two types of mixtures. The first is characteristic of many ordinary solid or liquid rocket-propellant exhaust gases, and contains the species H_2, H_2O, CO, CO_2, H, and OH. The reasons for assuming that these take part in four elementary (reversible) reactions of importance are given. The second example considers a mixture containing the active species H_2, H_2O, O_2, H_2, H, OH, and O, such as would be involved in a hydrogen-fueled ramjet, where eight elementary reactions are used. The relative significance of two-body and three-body reactions in influencing the gas composition and other flow variables is discussed. Author

N63-18575 Texaco Experiment Inc., Richmond, Va.
CONDENSATION IN NOZZLES
Welby G. Courtney *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 811–826 55 refs (See N63-18501 17-26)
(Supported by ONR)

A review is given of the theories of homogeneous nucleation and of growth during condensation from the vapor phase. At the present time, the usefulness of these theories remains uncertain or at least quite arguable. The principal current theoretical problems are the kinetic and thermodynamic behavior of ultra-small particles, and particularly, the accommodation coefficients for the growth of these particles and the possibility of non-Maxwellian vapor-particle collisions when growth is rapid. A detailed theoretical analysis of condensation in nozzles requires solution of the differential equations of nozzle flow

together with nucleation-growth kinetics. With rocket nozzles, the influence of chemical reactions among the variety of vapor species on nozzle aerodynamics and, particularly, on nucleation and growth kinetics must be included. The mathematical equations relating nucleations kinetics to chemical reactions are briefly noted in this paper, but the relevent specific rate constants are unknown. Author

N63-18662 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EXPERIMENTAL INVESTIGATION OF CHEMICAL REGENERATION OF SURFACES IN SIMULATED THERMIONIC DIODES
Helmut F. Butze and Arthur L. Smith Washington, NASA, July 1963 21 p 4 refs
(NASA TN D-1877) OTS: $0.50

An investigation was conducted to determine the feasibility of combating the sublimation of emitter material in thermionic diodes by means of chemical reactions, designed to transport the sublimed material from the collector back to the emitter. Tests were conducted in a system consisting of a tungsten emitter, a tungsten collector, and chlorine gas. A sapphire light pipe embedded in the collector was used to monitor the deposition and, subsequently, the removal of condensed tungsten from the collector surface. At emitter temperatures of about 2170° to 2550° K and collector temperatures of about 1460° to 1730° K, previously deposited tungsten was removed from the collector at partial pressures of chlorine of 10^{-4} torr and greater. The experimental results were consistent with those obtained in analytical studies, that suggested chemical transport reactions involving halogens as a possible mechanism for maintaining the structural integrity of emitter and collector surfaces. Author

N63-18738 Lockheed Missiles and Space Co., Sunnyvale, Calif.
OXIDATION OF TUNGSTEN AT ULTRA-HIGH TEMPERATURES. TECHNICAL REPORT: MATERIALS
R. A. Perkins, W. L. Price, and D. D. Crooks Nov. 1962 44 p 8 refs
(Rept. 6-90-62-98)

The oxidation behavior of tungsten in air and oxygen has been studied as a function of pressure (0.1 to 5.0 mm Hg) and gasdynamics at temperatures from 1,300 to 3,350° C (2,370 to 6,060° F). The development of a surface recession technique for rate measurement in static and dynamic atmospheres at low pressures is described. Grain size and orientation are shown to influence the rate of oxidation. Transport of oxygen in the system is a rate-limiting factor in static or turbulent air. Oxygen partial pressure in the reaction chamber varies with the temperature, surface area, and system geometry. High-velocity jet impingement is required to provide a known and constant value of oxygen pressure. Gaseous transport is not rate limiting in pure oxygen at pressures below 3 mm Hg and temperatures to 2,200° C (3,990° F). Identical oxidation rates are obtained by tests in static, turbulent, or high-velocity oxygen and high-velocity air. Two transitions in oxidation behavior with increasing temperature are observed. A reduction in temperature dependency and an increase in pressure dependency occurs at each transition. At all pressures, rates reach a maximum and decrease with increasing temperature above about 2,200° C (3,990° F). Equations which predict rate of oxidation at pressures of 10^{-6} to 3.0 mm Hg within ±20 percent of experimental values from three independent investigations are presented. Author

N63-18740 Naval Radiological Defense Lab., San Francisco, Calif.
THE DISPOSITION OF NA, MN, AND AL AT TWO CALIFORNIA BEACHES
F. M. Tomnovec and J. M. Ferguson May 9, 1963 19 p 4 refs
(USNRDL-TR-650)

The disposition of Na, Mn, and Al in California beaches was examined by studying two typical beaches, one near San Diego at Camp Pendleton, and one at Ocean Beach in San Francisco. A profile of the amount of Na, Mn, and Al contained in each beach soil is presented from the water's edge to several hundred feet inland. An attempt was made to follow the growth and leaching of Na from the Ocean Beach area over a period of several months during the winter (rainy season). During the 1963 rainy season, the experiment was abruptly terminated when the passage of a series of large storms removed the beach area where the experiment had taken place. Author

08 COMMUNICATIONS

Includes: communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation.

For tracking stations see: 10 Facilities.

For related information see: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation; and 22 Navigation and Guidance.

N63-18222 Nagoya U. Research Inst. of Atmospherics (Japan)
CALCULATED STATISTICAL CHARACTERISTICS OF ATMOSPHERIC RADIO NOISE
T. Nakai *In its* Proc. of the Res. Inst. of Atmospherics, Nagoya U., Vol. 10 Jan. 1963 p 13–24 2 refs (See N63-18220 17-21)

The Poisson noise process is considered in which the pulses of rectangular form with a constant duration are arriving at the times determined by Poisson's distribution law, and the average number of the observed pulses per second, the average duration of the observed pulses per second, and the probablity of time length which is occupied by the existence of the observed pulses in the noise process are deduced, respectively. Next, the deduced expressions of the parameters in Poisson's noise process are applied to the estimates of the same kind of parameters of a given voltage level of the envelope of the atmospheric noise by limiting their utilities in the direction of smaller amplitude probabilities at the high field-strength levels, on an assumption of a crossing rate function of the amplitudes of impulses in the atmospheric noise field at the input of the receiver. The expressions of the transformation factors (1) of the crossing rate, (2) of the probability, and (3) of the crossing rate and the probability are obtained. The approximate range of the field strength, or of the probability in which the expressions obtained may probably hold, is estimated. Author

N63-18262 Texas U. Electrical Engineering Research Lab., Austin
PROPAGATION MEASUREMENT IN THE VICINITY OF THE 183 Gc/s WATER VAPOR LINE
G. T. Coats, R. A. Bond, and C. W. Tolbert Feb. 5, 1962 20 p 9 refs
(Grant DA-SIG-36-039-61-G11)
(Rept. 7-20)

Recent investigations of atmospheric water-vapor absorption at frequencies of 172, 183.6, and 194 gc/s have produced values of 1.755, 4.15, and 0.881 db/km per g/m^3, respectively. It was found that the Van Vleck–Weisskopf equation predicts the same attenuation if it is assumed that the measured frequency was in error by 3.7 gc/s. Under this assumption, a line breadth constant of 0.18 cm^{-1} is required for the 183.6 gc/s water-vapor line, and the peak absorption for this line is calculated to be 5.78 db/km per g/m^3 for an absorption factor of 0.02736. Author

N63-18269 Michigan U. Radiation Lab., Ann Arbor
STUDIES IN RADAR CROSS SECTIONS XLVIII – DIFFRACTION AND SCATTERING BY REGULAR BODIES-II: THE CONE Scientific Report No. 5
R. E. Kleinman and T. B. A. Senior Jan. 1963 154 p 96 refs
(Contract AF 19(604)-6655)
(AFCRL-63-29; Rept. 3648-2-T)

Available information is summarized on the scattering of time harmonic electromagnetic waves by a perfectly conducting cone, either finite or infinite in extent, and embedded in a homogeneous, isotropic medium. Exact solutions for the infinite cone are given along with semi-infinite cone formulas, approximate results for a finite cone, and experimental data for flat-backed cones, cone spheres, and other terminations. P.V.E.

N63-18276 ITT Federal Labs., Nutley, N.J.
SOLID STATE TACAN MONITOR Final Report No. 1
F. M. Griffee and J. B. Carocari L. G. Hanscom Field, Bedford, Mass., Electronic Sys. Div., Mar. 1963 101 p
(Contract AF 19(604)-8459)
(ESD-TDR-63-321)

The design of a solid-state monitor for use as part of a TACAN ground station is given. A detailed description of the deliverable breadboard from both its physical and electrical aspects is provided, together with test results obtained to date, and recommendations for further development. Author

N63-18287 Ohio State U. Research Foundation. Antenna Lab., Columbus
WATER VAPOR ABSORPTION STUDIES WITH A HELIUM-NEON OPTICAL MASER
Ronald K. Long and Thomas H. Lewis Nov. 30, 1962 22 p 8 refs
(Contract AF 33(616)-7081)
(Rept. 1083-20)

Propagation characteristics of various lasers for potential application in communications are evaluated. Data are obtained from experimental measurements of the percent absorption of the 11522.82 Å laser radiation by water vapor and water-vapor–nitrogen mixtures as a function of pressure. Absorption at 6328 Å is also discussed and compared to absorption 11523 Å. The experimental results showed that, in some respects, 6328 Å would be superior to 11523 Å for communications. However, data have been presented to enable the design of system at 11523 Å if other factors lead to this choice. Because of the λ^4 wavelength dependence, for example, the IR wavelength would be superior to the visible as far as scattering is concerned. At optical wavelengths, the ultimate channel capacity may be limited by the number of photons/second available from the source. This, too, would favor a longer wave length. N.E.A.

N63-18318 New York U. Coll. of Engineering, N.Y.
SYNCHRONIZATION OF DECISION FEEDBACK SATELLITE TELEMETRY SYSTEMS Technical Memorandum No. 8
Bernard Harris and Robert Sommer Mar. 21, 1961 7 p
(NASA Contract NAS5-408)
(NASA CR-50610) OTS: $1.10 ph, $0.80 mf

The type of feedback system considered here is one where the receiving site commands the bird to repeat those portions of the transmission which are deeply embedded in the system noise. Various ways of synchronizing the feedback and direct channels are considered, so that the proper portion of the message is repeated, and the receiver can identify the repeated material. Author

N63-18322 New Mexico U. Engineering Experiment Station, Albuquerque
AN APPROACH TO CORRELATE PULSED RADAR AND PHOTOGRAPHIC DATA
Nasir Ahmed and W. W. Koepsel [1960] 71 p 15 refs
(NASA Grant NsG 129-61)
(NASA CR-50536; EE-89) OTS: $7.60 ph, $2.33 mf

This work describes an approach to the study of correlation between pulsed radar and photographic data, as a method of supplementing the available statistical information on area-extensive radar scattering surfaces. A measure of the scattered energy is obtained by studying the variance and power spectra of the radar and photographic data. These spectra are obtained by taking the Fourier transform of the respective autocorrelation functions obtained from the radar and photographic data. Therefore, the variance and power spectra are considered for correlation studies. The results seem to indicate that a correlation between the radar and photographic data depends on the nature of the terrain. Author

N63-18361 National Bureau of Standards, Boulder, Colo.
QUARTERLY RADIO NOISE DATA, SEPTEMBER, OCTOBER, NOVEMBER, 1962
W. Q. Crichlow, R. T. Disney, and M. A. Jenkins June 10, 1963 124 p 17 refs
(NBS-TN-18-16) GPO: $0.60

Radio noise measurements are being made at sixteen stations in a worldwide network supervised by the National Bureau of Standards. The results of these measurements for the period September, October, November 1962 are presented. These are based on three parameters of the noise: (1) the mean power, (2) the mean envelope voltage, and (3) the mean logarithm of the envelope voltage. Measurements of these parameters were made with the National Bureau of Standards Radio Noise Recorder, Model ARN-2, which has verticle antenna. The values presented reflect the actual measured radio noise; in some instances, the atmospheric noise level may be contaminated by manmade noise or station interference. N.E.A.

N63-18387 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
ASYMPTOTIC PERFORMANCE CHARACTERISTICS FOR MULTIRECEIVER COMMUNICATIONS THROUGH THE RICIAN MULTICHANNEL
W. C. Lindsey Apr. 30, 1963 21 p 19 refs
(NASA Contract NAS7-100)
(NASA CR-50655; JPL-TR-32-400) OTS: $2.60 ph, $0.83 mf

Ideal asymptotic performance characteristics are presented for two types of multireceivers—the coherent adaptive multireceiver and the noncoherent multireceiver. The transmitter for the system selects for transmission one of two equiprobable, equal-energy correlated waveforms. The selected waveform is transmitted into the Rician fading multichannel with additive gaussian noise superposed at the receiver end. The multichannel may take on one of four forms, i.e., it may change from one of a completely random nature to that of a completely fixed nature. All intermediate forms are permissible. It is shown that multichannel communication links containing fixed or specular

components have, inherent in their performance characteristics, an affinity for exponential factors. This attraction is independent of the receiver termination, regardless of whether or not it be coherent or noncoherent. On the other hand, multichannel communication links operating through multichannels of a completely random nature have an affinity for inverse factors, i.e., system performance increases or the probability of error decreases inversely with some power of the signal-to-noise ratio. Finally, it is shown that multichannel communication links containing combinations of purely fixed and random modes possess, in their performance characteristics, combinations of these inverse and exponential factors. At low error probabilities, the coherent multireceiver, which performs channel measurements, yields a 6-db improvement in signal-to-noise ratio over a noncoherent multireceiver which is ignorant of the channel state. This improvement is realized for both the completely random multichannel and the random multichannel supporting small fixed components. At low signal-to-noise ratios, an 8-db improvement may be realized. Author

N63-18395 Ohio State U. Research Foundation. Antenna Lab., Columbus, Ohio
RADAR BACK-SCATTERING MEASUREMENTS FROM "MOON-LIKE" SURFACES
W. H. Peake and R. C. Taylor May 1, 1963 18 p 2 refs
(NASA Grant NsG-213-61)
(NASA CR-50304; Rept. 1388-9) OTS: $1.60 ph, $0.80 mf

Measurements of back scattering from a number of rubble-like surfaces have been made for several polarization states. For such surfaces there is a qualitative relation between the surface roughness, and angular and polarization dependence of the back scatter. This relation may be used to estimate surface roughness, and perhaps dielectric constant, from back scattering measurements. Author

N63-18462 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
IN-FLIGHT AERODYNAMIC NOISE MEASUREMENTS ON A SCOUT LAUNCH VEHICLE
David A. Hilton, Emidio M. Bracalente, and Harvey H. Hubbard Washington, NASA, July 1963 19 p 11 refs
(NASA TN D-1818) OTS: $0.50

The results of free-flight surface-pressure measurements are presented for a Scout launch vehicle for Mach numbers up to about 4, free-stream dynamic pressures up to about 2,300 lb/sq ft, and Reynolds numbers based on vehicle length up to about 400 million. Useful data from two onboard microphones up to the time of second-stage ignition were telemetered to the ground station for recording and analysis. The overall surface-noise levels were noted to increase roughly as the dynamic pressure increased, but did not vary markedly as a function of Mach number. However, a Mach-number effect on the spectral content of the surface-noise pressures was noted as a general result of the tests. In particular, the spectra at the higher Mach numbers contained relatively more high-frequency noise and relatively less low-frequency noise than spectra measured at low speeds. The results of the tests are compared with available data from other free-flight studies. Author

N63-18483 General Dynamics/Astronautics, San Diego, Calif.
THE EXTENSION OF PARTIAL INFORMATION TO PROBABILITY DISTRIBUTIONS FOR DETECTION SPATIAL FILTERS
W. D. Montgomery *In* Chicago U. Labs. for Applied Sciences, Ill. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distribution [Spring 1962] Apr. 1963 p 107–117 8 refs (See N63-18473 17-10)

The idea of extending partial information of background noise to a "complete" probability distribution on a minimum information basis is applied in the context of detection spatial filters. Several two-dimensional moment descriptions are thus extended and worked out in detail. The application of these results to background radiance measurements is discussed in the conclusions. Author

N63-18647 Johns Hopkins U. Carlyle Barton Lab., Baltimore, Md.
DETECTION OF NON-GAUSSIAN PROCESSES IN NON-GAUSSIAN NOISE
Frank C. Ogg, Jr. June 1963 37 p 4 refs
(Contract AF 30(602)-2597)
(RADC-TDR-63-192)

The detection of stochastic processes in noise is considered, under the assumption that neither the signal nor the noise need be gaussian. The detector structure is found in terms of the semi-invariants of the signal and noise processes. The general detector structure is extremely complicated, but a threshold form may be obtained. For symmetric processes with zero mean and independent sampling, the energy detector is obtained. Error probabilities are computed for the energy detector with nongaussian signal process and/or nongaussian noise. It is shown that large degradations in sensitivity occur if the noise is highly impulsive in character, but the nongaussian character of the signal process is found to have very little effect on the detector sensitivity. Author

N63-18675 Illinois U. Antenna Lab., Urbana
APPLICATION OF CROSS-CORRELATION TECHNIQUES TO LINEAR ANTENNA ARRAYS
Robert H. Mac Phie Mar. 1963 168 p 54 refs
(Contract AF 33(657)-10474)
(Tech. Rept. 67)

This thesis is concerned with the application of cross-correlation techniques to linear antenna arrays. The basic cross-correlation system, which is considered, consists of two linear receiving arrays excited by a distribution of remote radio sources. The terminal voltage of each array is passed through a narrow-band RF filter, and the two resulting signals are cross-correlated. It is demonstrated that this system can measure the mutual coherence function of the source distribution. To do this, the patterns of the two antennas must be scanned independently. A Fourier analysis shows that the cross-correlation system's output is a filtered version of the mutual coherence function. From this output, a three-dimensional principal solution can be deduced; it is a generalization of the one-dimensional principal solution given by Bracewell and Roberts in connection with radio astronomy. Author

09 ELECTRONICS

Includes: circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory.

For related information see: 06 Auxiliary Systems; 08 Communications; 15 Instrumentation; 22 Navigation and Guidance; and 25 Physics, Solid-State.

N63-18227 Kaiser Aircraft and Electronics. West Coast Electronics Lab., Palo Alto, Calif.
SUMMARY REPORT OF KAISER ANIP PARTICIPATION, 1954-1962
D. J. O'Brien May 1, 1963 39 p 9 refs
(Contract Nonr-1076(00))

A summary of Kaiser ANIP (Army-Navy Instrumentation Program) is given for the following: (1) Kaiser–Aiken thin cathode-ray tube (internal structure, tube envelope, and sweep circuitry); (2) the electromechanical contact-analog generator; and (3) vacuumless displays (sweep circuitry and panel fabrication). N.E.A.

N63-18252 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.
A THEORY FOR BROADBAND VARACTOR PARAMETRIC AMPLIFIERS
Walter H. Ku Jan. 31, 1963 132 p 34 refs
(Contract AF 30(602)-2213)
(PIBMRI-1091-62; RADC-TDR-63-41)

This thesis is concerned with the development of a general and rigorous broadbanding theory for varactor parametric amplifiers. Fundamental gain-bandwidth limitations of a varactor parametric amplifier are obtained which are independent of the equalizer. Results obtained in this theory lead to the design and synthesis of broadband varactor parametric amplifiers. Author

N63-18256 Connecticut U., Storrs
USE OF A COORDINATE TRANSFORMATION IN THE INCREMENTAL PHASE PLANE
D. P. Lindorff [1963] 31 p 4 refs
(NASA Grant NsG-309-63)
(NASA CR-50457) OTS: $3.60 ph, $1.13 mf

A coordinate transformation in the incremental phase plane is introduced which facilitates the design of nonlinear sampled-data control systems. Use of these coordinates permits the slope of a boundary specified by the nonlinearity to be directly related to a simple gain term in the transformed system. A realizable form of compensation is shown to evolve in terms of the system variables. By using the transformed coordinates, it is possible to identify within each sectionally linear region of the phase plane a unique equation for the isoclines. Examples are presented to illustrate the method; these involve contactor, saturation, and quantization-type nonlinearities. Author

N63-18299 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.
SYNTHESIS OF TWO-TERMINAL CONTACT-DIODE NETWORKS
E. J. Smith, C. M. Healy, and W. C. W. Mow Apr. 15, 1963 30 p 18 refs
(Grant AF-AFOSR-62-295)
(PIBMRI-1144-63)

An approach to the design of contact-diode networks having different forward and reverse transmission functions is described. Linear graph theory forms the basis for the synthesis procedure which is an extension of Gould's method. The properties of single-diode networks are considered first. For such networks, the two specified forward and reverse transmission functions are mapped onto a single-contact switching function. Next, an oriented circuit matrix is obtained, and the synthesis of a graph corresponding to the matrix is attempted on a maximum-loop basis. If no graph exists, the number of columns in the matrix (correspondingly increasing the number of diodes or contacts) must be increased until one such matrix yields a realizable network. Author

N63-18300 California U. Lawrence Radiation Lab., Berkeley
DEFLECTOR POWER SUPPLY FOR SECTOR-FOCUSED CYCLOTRONS
Bob H. Smith Mar. 25, 1963 31 p 1 ref
(Contract W-7405-eng-48)
(UCRL-10655) OTS: $0.50

Because of the higher particle energy, sector-focused cyclotrons require higher gradients in their electrostatic deflectors than ordinary cyclotrons. A higher operating gradient can be achieved by exciting the deflector from a low-energy-storage power supply, which permits control of the electrode surface heating during each spark. A pair of high-frequency Cockcroft–Walton rectifiers with this capability has been built for the Lawrence Radiation Laboratory's 88-Inch Cyclotron. Each rectifier consists of a six-stage circuit designed to deliver 120 kv at 5 ma. It is driven by a 100-kc oscillator. The rectifier is built from inexpensive silicon diodes, each with a rating of 600 piv, 0.75 A, and a storage time of 2 μsec. The diodes are assembled on etched circuit boards. Between decks of the rectifier, 900-pF, 30-kv ceramic capacitors, similar to those in television sets, are used. The d.c. output voltage is controlled by plate modulation of the oscillator and regulated to 0.01% by an electronic regulator. The rectifier is protected against spark-induced surge currents by an electronic crowbar operating on the screen grid of the oscillator. Author

N63-18324 Ohio State U. Research Foundation. Antenna Lab., Columbus
THE USE OF THE JUNCTION DIODE AS A LOW TEMPERATURE THERMOMETER
Glenn G. Shepard Jan. 31, 1963 20 p 1 ref
(Contract AF 33(616)-7081)
(Rept. 1083-22)

The nonlinear resistance-temperature (at low temperature, in particular) characteristic of a semiconductor junction can be combined with the nonlinear effect of a d.c. bridge to produce a linear variation of temperature with a particular resistance. This memorandum details the manner in which the bridge produces a linear variation of temperature with ΔR according to the expression $\Delta R = A + BT$. This temperature-monitoring device was used successfully over the range from 273° K to 77° K. Recent studies have shown the validity of extending this lower limit down to liquid-helium temperature (≐ 4° K). Author

N63-18350 Duke U., Durham, N.C.
REGULATED D-C TO D-C SCR CONVERTER EMPLOYING NONLINEAR TWO-CORE TRANSFORMER
Thomas G. Wilson, Edward T. Moore, and Ihsan M. H. Bábaâ N.Y., Inst. of Elec. and Electron. Engr. [1963] 20 p 10 refs Presented at the IEEE Summer General Meeting and Nuclear Radiation Effects Conf., Toronto, June 16–21, 1963
(NASA Grant NsG-152-61, Suppl. 1-62)
(NASA CR-50556; IEEE Paper 63-1090) IEEE: $0.60 members, $1.00 nonmembers

A nonlinear two-core transformer turns off controlled rectifiers in the inverter stage of a d.c. to d.c. converter. This nonlinear transformer and the bistable characteristics of the SCR's make possible the variable duty-cycle regulation method employed. Low transient impedance of the inverter stage is used during starting to avoid transient loading problems involving the large output filter capacitance. With an inverter frequency of 725 cps, an overall d.c. to d.c. conversion efficiency in excess of 80% is achieved. Author

N63-18362 Watkins-Johnson Co., Palo Alto, Calif.
Monthly Technical Progress Report, June 1, 1963–June 30, 1963 [DEVELOPMENT OF A GRIDDED 100 KW L-BAND AMPLIFIER SUITABLE FOR APPLICATION IN PHASED-ARRAY RADAR SYSTEMS]
M. V. Purnell July 10, 1963 2 p
(Contract AF 19(628)-500)
(Rept. 19; W-J 63-434R19)

Work proceeded on development of a gridded 100 kw L-band amplifier suitable for application in phased array radar

systems. A metal barrel tube was tested and operated without arcing with voltages up to 30 kv with a cold cathode, but arced consistently at about 10 kv with beam current on. Transmission characteristics obtained during the focusing of the ceramic barrel tube were so inconsistent that the usefulness of this tube for focusing tests may be in question. P.V.E.

N63-18376 Rome Air Development Center. Techniques Lab., Griffiss AFB, N.Y.
UHF NEGATIVE GRID TETRODE PEAK CATHODE EMISSION TESTS
Merton C. Kraft June 1963 29 p
(RADC-RAL-TM-63-8)

This report covers the testing of UHF power-amplifier tubes to determine the peak cathode-emission capabilities and probable maximum RF power output at a pulse duration of 200 microseconds. Author

N63-18377 Rome Air Development Center. Techniques Lab., Griffiss AFB, N.Y.
POLARIZATION CONSIDERATIONS FOR A DUAL CHANNEL RECEIVING ELEMENT
Edward J. Christopher and John A. Potenza June 1963 20 p
(RADC-RAL-TM-63-9)

This report discusses a means of optimumly receiving electromagnetic energy from a wave whose polarization is not necessarily constant or known. The recently increase in ranges covered by radar and communication systems requires consideration of the effects of Faraday rotation on the polarization of the received signal. Equations for the apparent loss within the system as a function of polarization of the incident signal are set forth. These equations point out possible modifications of the basic configuration in order to enhance receiving performance. Graphs which support these equations are included.
Author

N63-18407 Stanford Research Inst., Menlo Park, Calif.
FLUX SWITCHING IN MULTIPATH CORES Report 1
D. Nitzan, J. R. Anderson, and J. D. Noe Nov. 1961 230 p 151 refs
(NASA Contract NASw-6; JPL Contract 950095)
(NASA CR-50058) OTS: $15.00 ph, $7.10 mf

A multipath ferrite core is divided into legs whose properties constitute the flux-switching characteristics of the core. Flux switching due to rotation of magnetization and domain growth is divided into elastic and inelastic components. The switching characteristics of each individual leg are expressed in terms of the static ϕ-F loop, elastic parameter ϵ and inelastic parameters ρ and F_p. Based on these parameters, each leg is represented by an electrical-circuit analog. The assembly of these analogs, according to the physical layout of the individual legs, represents the electrical-circuit analog of the multipath core. These analogs facilitate the computation of ϕ, ϕ and F in each leg during switching time. Other means to express flux switching are described. These include a ring-element model that assumes slow switching and ϕ-F curves that represent the net change in ϕ due to a given F pulse. Author

N63-18410 Electro-Optical Systems, Inc., Pasadena, Calif.
FUEL CELL ASSEMBLIES First Quarterly Report, 10 Apr.-10 July 1962
Harvey Frank, C. W. Stephens, and J. Neustein July 10, 1962 61 p 4 refs
(NASA Contract NAS7-100; JPL Contract 950258)
(NASA CR-50564; EOS-3070-Q-1) OTS: $6.60 ph, $2.03 mf

The development of multicell regenerative hydrogen-oxygen fuel cell assemblies is reviewed. Fabrication of the first prototype assembly is nearing completion. Processing procedures have been established for the fabrication of electrodes, electrolyte bed, and cell spacers. Tentative quality control specifications have been written for all materials. The proper sized manifolds, gas distribution channels, O-rings, and compression of the cell stack have been established by the supporting fuel cell investigations. Additional studies have indicated that (1) pure nickel is the best metal and silicon rubber the best rubber material for the corrosive environment within the cell, and (2) mixtures of hydrogen and oxygen at 100 psig and room temperature do not react explosively in the presence of the platinized nickel-potassium hydroxide-asbestos assembly. I.v.L.

N63-18459 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
POWER TRANSISTOR COOLING IN A SPACE ENVIRONMENT
James E. A. John and John J. Hilliard Washington, NASA, July 1963 13 p 9 refs
(NASA TN D-1753) OTS: $0.50

The cooling of power transistors was investigated in a space environment, where the only available mode of heat transfer is conduction to a heat sink and radiation from the heat sink to space. An attempt was made to minimize the thermal resistance between the transistor case and the heat sink, so that the transistor would dissipate as much power as possible while maintaining its temperature within the maximum tolerable level to prevent thermal runaway. Further, it was necessary to electrically insulate the transistor from the heat sink. Beryllium oxide washers provided electrical insulation and added very little to the thermal resistance between case and sink, the BeO being a good heat conductor. However, the problem of contact thermal resistance at each interface arose, especially in vacuum; this contact resistance provided practically all the thermal resistance between case and sink. The effect on the contact resistance of surface pressure, insertion of foil, and soldering was examined. It was concluded that, for the most efficient cooling, indium foil should be inserted at each interface, the indium foil having the effect of reducing the contact resistance in vacuum by a factor of 8. Author

N63-18625 Technical Research Group, Syosset, N.Y.
AMPLIFICATION BY RESONANCE SATURATION IN MILLIMETER WAVE CAVITIES Technical Note No. 3
Benjamin Senitzky and Sylven Cutler May 23, 1963 29 p 8 refs
(Contract AF 30(602)-2744)
(RADC-TDR-63-253)

A resonant cavity filled with $HC^{12}N^{14}$ gas has been used to obtain amplification of electromagnetic radiation of 3.4-mm wavelength. An incoming radiation spectrum, consisting of a local oscillator component which is sufficiently intense to saturate the 3.4-mm rotational resonance of the gas and weak sidebands (information signal), is reflected from the gas-filled, 3/4-inch-diameter, 6-inch-long cylindrical cavity. Under certain conditions, the nonlinear properties of the gaseous medium can be used to yield a stable information signal gain of 20 db.
Author

N63-18628 Watkins-Johnson Co., Palo Alto, Calif.
DEVELOPMENT OF S-BAND LOW-NOISE PERIODIC PERMANENT MAGNET TRAVELING-WAVE TUBE Final Report
B. P. Israelsen, J. H. Foster, M. V. Purnell, and F. T. Mauch Mar. 19, 1963 56 p 5 refs
(Contract AF 30(602)-2694)
(W-J-63-604R4; RADC-TDR-63-172)

Various methods of focusing a low-noise electron beam are described. Experimental results for reversed-field, combined straight and periodic fields, and shielded straight-field focusing are presented. Effective means for shielding a straight-field magnet and eliminating its transverse components on the axis were found. Developments in the low-noise tube which facilitated permanent-magnet focusing are described. These include the pin-seal input match, and a considerable reduction in the gun bulb and coupler diameters. Operation of the amplifier is simplified by the inclusion of a voltage divider network to furnish the helix and anode voltages. Performance of the completed amplifiers with regard to gain, noise figure, and phase is discussed. Author

N63-18640 Motorola, Inc., Phoenix, Ariz.
STUDY OF FAILURE MECHANISMS AT SURFACES AND INTERFACES Final Report
Kenneth Greenough, Frank Reed, and Neva Johnson Griffiss AFB, N.Y., Rome Air Development Center, Mar. 1963 99 p 10 refs
(Contract AF 30(602)-2593)
(RADC-TDR-63-152)

The investigation of the interface between a metal film and a thin-film dielectric, e.g., tantalum–tantalum oxide, aluminum–aluminosilicate glass, incorporated in thin-film capacitors has been most successful in providing the fundamental information necessary to identify and quantitatively define the characteristic failure mechanisms at these interfaces. The frequency dispersion of capacitance and dissipation factor for the tantalum–tantalum oxide system fits a curve predicted by a mathematical model of the interface based on an exponentially varying resistivity across the interface. The slopes of the capacitance and dissipation factor versus frequency curves which exhibit an inverse relationship to dielectric thickness and changes in the shapes of these curves brought about by thermal and humidity stressing, can also be correlated with the interface model involving a variation in resistivity with position relative to the interface. Preliminary investigations of the characteristics of leakage current versus applied voltage curves for various metal-glass dielectric interfaces indicate that the observed trap-limited, space-charge limited currents are a function of the nature of the metal electrode interface and applied thermal stress. The applied voltage-leakage current studies will be valuable in evaluating failure mechanisms originating at the metal-dielectric interface. Results of the investigations on the various semiconducting tin oxide film-substrate model systems have been revealing in terms of the qualitative nature of possible failure modes associated with the nature of the substrate interface. Observations of changes in the basic conduction mechanism as a function of applied thermal and electrical stress are accomplished by measurement of changes in the Hall mobility and its temperature dependence, and the Hall constant. Stressed-induced changes in the conduction mechanism of the electronically degenerate film are qualitatively described in terms of high resistivity crystallite grain boundary regions of the polycrystalline film. Author

N63-18641 Ohio State U. Research Foundation. Antenna Lab., Columbus
ANALYSIS AND DESIGN OF TUNNEL DIODE DIPOLE ANTENNAFIERS
Kyohei Fujimoto May 15, 1963 106 p 6 refs
(Contract AF 33(657)-10386)
(Rept. 1566-1)

Four types of loaded-dipole antennas, which are variations of the double-H antenna, depending on the place of the loading, are discussed as to input impedance, gain, and noise performance. Experimental measurements of these quantities show fairly good agreement with theoretical calculation. However, the measurements are difficult to repeat. The main sources of discrepancy seem to be the uncertainty of diode impedance and indefinite quantities, such as stray impedances, which exist in practical antenna structures. I.v.L.

N63-18646 Philco Corp. Communications and Electronics Div., Philadelphia, Pa.
CONSTANT BANDWIDTH R. F. PRESELECTOR FILTERS
Quentin Veit Griffiss AFB, N.Y., Equipment Lab., June 1963 10 p 2 refs
(Contract AF 30(602)-2331)
(RADC-TDR-63-221)

This technical note describes the RF preselector filters developed for the AN/TRC-56 radio unit. Unusual properties of the filters are their wide tuning range and constancy of bandwidth over their tuning range. A description of, along with the test results for, the filters is included. Author

N63-18649 Chalmers U. of Tech. Research Lab. of Electronics, Goteborg (Sweden)
ON THE NON-LINEAR THEORY OF THE PLANE TRAVELING WAVE TUBE Technical Note No. 1
S. Olving Mar. 1, 1963 48 p 13 refs
(Contract AF 61(052)-594)
(RADC-TDR-63-333; Res. Rept. 37)

An infinitely wide electron beam interacts with an infinitely wide homogeneous slow-wave structure, whereby the difficulties associated with radial boundary conditions are avoided. The nonlinear wave equation is solved to the third-order accuracy by the use of the method of successive approximation. The one-valued velocity assumption limits the analysis to the range well below the saturation level. Within this range, however, the results describe such effects as the dependence of fundamental frequency gain and output phase on drive power, the production of the first two harmonics, etc. Furthermore, it is shown that, by the use of suitable approximations, one can write the nonlinear plane TWT equation in a form very similar to the exact nonlinear plane klystron equation. From this point on, one can deal with the plane TWT using the methods which have already been successfully applied in the plane klystron case. Author

N63-18674 Microwave Associates, Inc., Burlington, Mass.
APPLICATION OF SEMICONDUCTOR DEVICES TO HIGH POWER DUPLEXERS Fourth Quarterly Progress Report, 1 Nov. 1962-31 Jan. 1963
Joseph White Apr. 30, 1963 21 p
(Contract AF 30(602)-2656)
(RADC-TDR-63-225)

A program for this quarter had the following aspects: (1) Semiconductor diodes were made and installed in a special water-cooled package intended to combine the low thermal-resistance features of the integrated junction, discussed in earlier reports, with the surface passivation and assembly advantages of the packaged diode. (2) An improved RF circuit was designed which can be used to optimize the high-level power capability vs. the low-level insertion loss, once the number of diodes to be used has been chosen. Author

N63-18701 Utah U. Microwave Devices Lab., Salt Lake City
MICROWAVE DEVICES LABORATORY CONSOLIDATED QUARTERLY REPORT FOR THE PERIOD JANUARY 1, 1963 TO MARCH 31, 1963
Mar. 31, 1963 96 p 28 refs
(Contracts Nonr 1288(05); AF 04(647)-745; AF 33(657)-8677; NSF Grant G-15017)
(Tech. Rept. MDL-Q4)

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B. PLASMA GENERATION AND MEASUREMENTS V. Gilson and C. C. Johnson p 58-84 10 refs (See N63-18713 17-24)

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E. THERMIONIC EMISSION FROM CONDENSED SPECIES IN ROCKET EXHAUSTS C. K. Bullock and C. C. Johnson p 88-93 2 refs (See N63-18716 17-24)

N63-18702 Utah U. Microwave Devices Lab., Salt Lake City
A 30-40 kMc MULTIPLE-LADDER CIRCUIT BACKWARD-WAVE OSCILLATOR
L. S. Bowman, D. R. Gunderson, and R. W. Grow *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 1-5 1 ref (See N63-18701 17-09)
(Contract AF 33(657)-8677)

Progress is reported on a project designed to investigate the feasibility of using multiple-coupled ladders in backward-wave oscillators at millimeter wavelengths. A 30 to 40 kmc oscillator is being constructed as the first step in this evaluation. During this period, 0.005-in. molybdenum ladder planes were photoetched, a brass housing for the ladder was made, and the cold tests circuit was assembled. Experiments are being performed to obtain the optimum match to the output waveguide at the gun end and to terminate the ladder planes effectively at the collector end. The decision was made to use the Watkins-Jonnson 4A electron gun in the oscillator. A theoretical investigation has been carried out to determine if a cylinder of high permeability, slipped partially into the solenoid, might give the desired field configuration for convergent confined flow using the W-J 4A gun. It was determined that the cylinder will slip handily inside the 1875 diameter solenoid. N.E.A.

N63-18703 Utah U. Microwave Devices Lab., Salt Lake City
DIELECTRIC SLOW-WAVE CIRCUITS
C. H. Durney and R. W. Grow *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 6-13 3 refs (See N63-18701 17-09)
(Contract Nonr-1288(05))

The possibility of using smooth slow-wave circuits at millimeter wavelength is investigated. After the design of the X-band experimental traveling-wave tube using a thin walled dielectric tube circuit, problems were encountered in obtaining the thin-walled dielectric tube circuit. Preliminary investigations of this analysis indicated that the rectangular circuit appears to be suitable for an experimental X-band traveling wave tube. N.E.A.

N63-18704 Utah U. Microwave Devices Lab., Salt Lake City
THE ORBITRON AMPLIFIER
W. L. Dickson, R. L. Schriever, and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 14-21 (See N63-18701 17-09)
(Contract AF 33(657)-8677)

The objective of this project is to develop a high-frequency, high-power amplifier utilizing the interaction between a spiraling electron beam and the fields in an unloaded waveguide. The electron gun was designed and construction initiated. In order to evaluate the performance of the gun, a test circuit was designed and completed. The characteristics of the circuit are presented. N.E.A.

N63-18705 Utah U. Microwave Devices Lab., Salt Lake City
A CYCLOTRON-SYNCHRONOUS WAVE AMPLIFIER
James E. Dalley and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 22-31 (See N63-18701 17-09)
(Contract Nonr-1288(05))

The theoretical and experimental studies were directed toward achieving high efficiency by coupling the fast cyclotron wave and the negative energy synchronous wave in an axially symmetric electrostatic field. In such a device, all electrons experience nearly equal forces and a depressed collector can be effectively employed to improve the efficiency. It was felt that variable tuning and coupling were necessary and methods of achieving these goals were developed for an evaluated cavity. The tuner and coupler and discussed. N.E.A.

N63-18706 Utah U. Microwave Devices Lab., Salt Lake City
MULTIPLE-BEAM INTERACTIONS
P. J. Watts and R. W. Grow *In its* Microwave Devices Lab. Consolidated Quarterly Report Mar. 31, 1963 p 31-32 2 refs (See N63-18701 17-09)
(Contract AF 33(657)-8677)

The objective of this project is to investigate the possibility of using the interaction between multiple electron beams occupying the same space so as to build millimeter wave amplifiers and oscillators. The equation describing the interaction has been written and an attempt is being made to program an IBM 7090 computer to solve it. The first case to be considered will be that of the double-stream completely filling a conducting cylinder. N.E.A.

N63-18707 Utah U. Microwave Devices Lab., Salt Lake City
MAGNETO-ELECTRIC BEAM COMPRESSION
L Kikushima and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 32–36 1 ref (See N63-18701 17-09)
(NSF Grant G-15017)

The object of this study is to obtain a high current-density electron beam of the order of 5,000 amperes per square centimeter, using magnetic compression in combination with a high convergence gun. A high perveance and high area compression electron was selected for use in the magnetoelectric compression system. Beam perveance and profile measurements were made on the new gun in a demountable beam tester. To make tests in a solenoid, a hard tube with an internal pole piece was designed. A method to measure the beam diameter with the beam in a high magnetic field was devised. Tests showed that the beam diameter was very nearly as calculated, and therefore a Brillouin focused beam of 2,500 amps per square cm was obtained with a power density of 25 megawatts per square cm.
N.E.A.

10 FACILITIES

Includes: airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations.

For related information see: 06 Auxiliary Systems.

N63-18224 Nagoya U. Research Inst. of Atmospherics (Japan)
MOSHIRI OBSERVATORY IN HOKKAIDO
Akira Iwai *In its* Proc. of the Res. Inst. of Atmospherics, Nagoya U., Vol. 10 Jan. 1963 p 35–36 (See N63-18220 17-21)

Because of the lack of information on VLF emissions from atmospherics and because other observatories have been unsuitable, due to manmade noise interference, for recording of data, a new observatory is being built at Moshire. This observatory will make use of a pair of loop antennas and a vertical antenna to measure the intensity, arrival direction, and polarization of whistlers and VLF emissions. Routine observation of whistlers is made at 20 to 22 minutes and 50 to 52 minutes every hour. The observation of VLF emissions is made continuously with respect to the intensity and polarization at 5 kc/s. The intensity spectrum from 1 kc/s to 30 kc/s is recorded simultaneously to discriminate VLF emissions from manmade noise.
P.V.E.

N63-18473 Chicago U. Labs. for Applied Sciences, Ill.
SYMPOSIUM ON BACKGROUND RADIATION. ULTRAVIOLET, VISIBLE AND INFRARED LEVELS AND DISTRIBUTIONS [SPRING 1962]
Lucien M. Biberman et al Apr. 1963 122 p 37 refs
(ARPA-SD-71)
(LAS-TR-199-36)

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1. MECHANISMS OF AURORAL RADIATION C. Y. Fan (Chicago U.) p 2–15 1 ref (See N63-18471 17-12)

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7. THE UNIVERSITY OF DENVER HIGH-ALTITUDE INFRARED BACKGROUND INVESTIGATION D. G. Murcray (Denver U.) p 86–94 (See N63-18480 17-15)

8. MEASUREMENT PROGRAMS IN THE VISIBLE A. R. Boileau (Calif. U.) p 96–102 (See N63-18481 17-15)

9. PHOTOGRAPHIC CONTRAST ATTENUATION BY THE ATMOSPHERE R. Sink (Aeronautical Systems Div.) p 103–107 (See N63-18482 17-21)

10. THE EXTENSION OF PARTIAL INFORMATION TO PROBABILITY DISTRIBUTIONS FOR DETECTION SPATIAL FILTERS W. D. Montgomery (General Dynamics/Astronautics) p 107–117 8 refs (See N63-18483 17-08)

N63-18487 Philco Corp. Western Development Labs., Palo Alto, Calif.
FACILITY REQUIREMENTS AND CRITERIA Technical Report
R. S. Cronhardt Sept. 7, 1962 54 p
(NASA Contract NAS9-366)
(NASA CR-50563; WDL-TR-E112-3) OTS: $5.60 ph, $1.82 mf

The purpose of this report is to outline the requirements placed on the structure which houses the Integrated Mission Control Center and to set forth the basic criteria which must be documented to implement the technical equipment and operational facilities within the building. Facilities under discussion are as follows: communication, data processing, mission operation, simulation and checkout, and support.
I.v.L.

N63-18588 Shell Development Co., Emeryville, Calif.
MODELING TECHNIQUES IN REACTOR DESIGN
C. H. Barkelew *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 958–964 7 refs (See N63-18501 17-26)

In many chemical operations for which large-scale reactors must be designed, the rate of reaction is influenced by the fact that chemical and physical processes may proceed with comparable rates. This leads to considerable difficulty in constructing appropriate models for studying the behavior of reactors. In this paper, a few representative techniques which have been found useful are described, and compared with methods for modeling combustion chambers.
Author

N63-18682 Bureau of Mines, Washington, D.C.
FIRE AND EXPLOSION HAZARDS ASSOCIATED WITH LIQUEFIED NATURAL GAS
David Burgess and Michael G. Zabetakis 1962 39 p 19 refs
(BM-RI-6009)

The factors to be considered in an evaluation of the fire and explosion hazards associated with any fuel are each discussed briefly. These factors are then used to assist in the design of experiments for the evaluation of the hazards associated with liquefied natural gas (LNG), relative to those associated with other common fuels. Experiments have been conducted on the vaporization of LNG, the mixing of LNG vapors

with air, the effect of temperature and nitrogen dilution on the limits of flammability of methane in air, the burning rates of LNG and other fuels, flame radiation, and extinguishment of fires above liquid pools. Based on the results of these experiments, LNG can be stored safely in suitably designed above-ground tanks surrounded by earthen dikes in much the same manner as gasoline. Author

11 FLUID MECHANICS

Includes: boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow, 03 Aerodynamics of Wings and Control Surfaces; 13 Heat Transfer; and 24 Physics, Plasma.

N63-18249 Cornell U. Graduate School of Aerospace Engineering, Ithaca, N.Y.
ON ALIGNED-FIELDS MAGNETOGASDYNAMIC FLOWS WITH SHOCKS
Nima Geffen Feb. 1963 122 p 22 refs
(Partially supported by AFOSR)

The steady magnetogasdynamic flow of an inviscid perfect conductor in the sonic, Alfvénic, and hypercritical transition regimes is treated. A consistent nonlinear small-perturbation theory is developed, approximate shock relations derived by a new method, and the flow around two-dimensional and axisymmetric bodies investigated. It is found that the transonic magnetogasdynamic system of equations can be reduced to the conventional gasdynamic transonic system and an explicit correspondence established between congruent flows in the two cases. A few new gasdynamic trailing-edge flows are constructed, and detailed leading- and trailing-edge magnetogasdynamic flow patterns covering the whole transonic range are presented and discussed. The hypercritical and transonic systems are mathematically similar, and familiar transonic methods can be used to investigate hypercritical flows. General properties of the hypercritical flow field are deduced, and a few qualitative flow patterns presented and discussed. Author

N63-18250 Princeton U., N.J.
AN EXPERIMENTAL INVESTIGATION OF THE SEPARATION OF A HYPERSONIC BOUNDARY LAYER OF A FLAT PLATE. PART I: PRESSURE DISTRIBUTION AND OPTICAL STUDIES AT M = 11.7
W. J. Graham and I. E. Vas Wright-Patterson AFB, Ohio, Aeronautical Res. Labs., May 1963 49 p 9 refs
(Contract AF 33(616)-7629)
(ARL 63-74)

A study was carried out in the Princeton University 3-inch helium hypersonic wind tunnel at a Mach number of 11.7 to examine the flow over a flat plate with disturbances located at a distance from the leading edge. The leading-edge Reynolds number was varied from 190 to 20,900. The disturbances, varying in shape from a 10° to a 30° wedge, a 90° step, and one with a hemicylindrical shape, were investigated over the leading-edge Reynolds-number range. Schlieren photographs and detailed surface-pressure distributions were obtained to determine the location of the separation point and the pressure ratio across the separation region. Author

N63-18254 Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge
MEASUREMENTS OF NEAR FIELD PRESSURES OF SUBSONIC JETS
E. Mollo-Christensen Apr. 1963 54 p 18 refs
(NASA Grant NsG-31-60)
(NASA CR-50585; ASRL-TR-1009) OTS: $5.60 ph, $1.82 mf

This paper reports on a series of measurements of pressure space–time covariance in the near field of several subsonic jets. The data include measured mean flow data, turbulence levels, and power spectral densities of the pressure field outside the jet. The far field is first established for high frequencies as the distance between jet and detector are increased. One result is the long correlation distances for the larger eddies and the strong correlation across a diameter observed both in the transitional regime and in the fully turbulent domain. The correlation measurements show a distinction between phase velocity and group velocity of large-scale disturbances. Author

N63-18263 Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.
XITE – A DIGITAL PROGRAM FOR THE ANALYSIS OF TWO-DIMENSIONAL BOILING FLOW TRANSIENTS WITH FLUID EXPANSION
R. P. Rose and R. S. Pyle Apr. 1963 47 p 3 refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-302) OTS: $1.00

A description of the XITE program for analysis of steady-state and transient behavior in a single reactor coolant channel is presented. The XITE program, like its predecessor TITE, represents a vertical rectangular channel with two-dimensional flow, and a nonuniform axial and transverse heat-flux distribution at the walls. Unlike the TITE program, XITE includes the time derivative of fluid density in the continuity equation such that more rapid transients (e.g., flow oscillations) can be analyzed. The XITE model treats two-dimensional convection of mass, momentum, and energy in the coolant for subcooled, nucleate, and bulk boiling conditions. Time variations in power, inlet enthalpy, and either inlet mass velocity or channel pressure drop may be imposed as transient driving functions. The XITE program was assembled by the ALTAC system for a 32,000-word Philco-2000 computer. Author

N63-18355 Royal Aircraft Establishment, Farnborough (Gt. Brit.)
GAS DYNAMIC REGULATION OF JET NOZZLE OF A TURBOJET ENGINE (GAZODINAMICHESKOE REGULIROVANIE REAKTIVNOGO SOPLA TRD)
A. G. Zenukov London, Ministry of Aviation, Mar. 1963 14 p 1 ref Transl. into ENGLISH from Izvest. Vyssh. Uchebn. Zav. MVO SSSR Ser. Aviats. Tekhn., v. 1, 1959 p 55–64
(RAE Library Translation 1031)

A method is described for obtaining thrust augmentation in turbojet engines, by using a device based on gasdynamic principles for regulating nozzle input. The investigations made for determining the most practical form of construction and establishing the most favorable operating ranges for such a device are discussed. Author

N63-18382 Lehigh U. Inst. of Research, Bethlehem, Pa.
AN EXPERIMENTAL STUDY OF TURBULENT SPOTS AND WALL ROUGHNESS EFFECTS IN SHOCK TUBE BOUNDARY LAYER TRANSITION
William Thompson, Jr. (Ph.D. Thesis) June 15, 1963 162 p 77 refs
(NSF Grant G-6350)
(Tech. Rept. 16)

Turbulent spots have been identified as a transition mechanism in shock-tube boundary-layer flows for a range of weak

shocks at initial pressures near one atmosphere in air, using thin-film wall temperature gages. The shape and growth rate of the spots is similar to that found by other investigators in subsonic and supersonic steady flows. A study of turbulent spots generated by sparks set off in the boundary layer, and of flow tripping by two- and three-dimensional roughness elements, has indicated the existence of a completely stable interval behind the shock, in which finite disturbances will not cause flow breakdown or transition to turbulent flow. The data are best correlated by a Reynolds number based on boundary-layer velocity thickness δ. The upper limit of the stable region, the origins of naturally and artificially produced turbulent spots, and the origin of turbulence induced by roughness elements, all fall in the Reynolds number range $Re_\delta = 1.0$ to 4.0×10^3, over a shock Mach number range 1.1 to 2.3. The ultimate persistence of laminar flow in the present experiments was limited by boundary-layer tripping at wall discontinuities. The maximum transition Reynolds numbers observed fall a factor of 5 higher than those seen by other investigators, and are only a lower bound on the maximum transition Reynolds numbers attainable in shock tube flow. Possible flow perturbations causing transition, and the implications of these measurements for stability theories of the shock tube boundary layer are discussed. Author

N63-18392 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THE EFFECT OF A STRONG MAGNETIC FIELD ON TWO-DIMENSIONAL FLOWS OF A CONDUCTING FLUID
Stephen Childress Mar. 1963 14 p 7 refs Repr. from J. Fluid Mech., v. 15, Pt. 3, 1963 p 429–441
(NASA Contract NAS7-100)
(NASA CR-50653; JPL-TR-32-296)

The motion of a viscous, electrically conducting fluid past a finite two-dimensional obstacle is investigated. The magnetic field is assumed to be uniform and parallel to the velocity at infinity. By means of a perturbation technique, approximations valid for large values of the Hartmann number M are derived. It is found that, over any finite region, the flow field is characterized by the presence of shear layers fore and aft of the body. The limit attained over the exterior region represents the two-dimensional counterpart of the axially symmetric solution given by Chester. Attention is focused on a number of nominally "higher order" effects, including the presence of two distinct boundary layers. The results hold only when $M \gg Re$; Re = Reynolds number. However, a generalization of the procedure, in which the last assumption is relaxed, is suggested. Author

N63-18465 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A METHOD OF ASYMPTOTIC EXPANSIONS FOR SINGULAR PERTURBATION PROBLEMS — APPLICATION TO VISCOUS FLOW OVER A FLAT PLATE
E. Dale Martin Washington, NASA, July 1963 127 p 37 refs (NASA TN D-1886) OTS: $2.75

A method of asymptotic expansions for solving a class of singular perturbation problems, including the boundary-layer type, is developed. Detailed description of the method and its application to different types of problems is provided. Simple examples are used to aid in understanding and to illustrate procedures. The method, which accounts precisely for displacement effects in matching outer and inner expansions, can be used in the solution of some types of problems which were heretofore intractable. The method is applied to obtain the asymptotic expansion of the exact solution to the Navier-Stokes equations for incompressible continuum flow over a semi-infinite flat plate in a uniform stream. Until the present time, this fundamental problem, although intensively investigated since the application of Prandtl's first-order boundary-layer theory by Blasius, had not been correctly solved to higher orders. In the present solution, it is found that exponential decay of vorticity, a criterion used by previous investigators in attempts to construct higher order solutions, is automatically satisfied. Author

N63-18471 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SIMILARITY SOLUTIONS FOR SMALL CROSS FLOWS IN LAMINAR COMPRESSIBLE BOUNDARY LAYERS
Ivan E. Beckwith Washington, GPO, 1961 28 p 8 refs (NASA TR R-107) GPO: $0.40

The compressible laminar boundary-layer equations for an arbitrary three-dimensional body are reduced to a form analogous to the corresponding equations for axisymmetric flow. This simplification results from the use of a streamline coordinate system and the assumption that the component of boundary-layer flow normal to the external streamline (cross flow) is small. The streamwise skin friction and heat-transfer distributions on the arbitrary body are then independent of the cross flow. Formulas for computing these distributions are adapted from a local similarity method originally derived for a body of revolution. Author

N63-18503 Massachusetts Inst. of Tech., Cambridge
MIXING ANF FLOW IN DUCTED TURBULENT JETS
H. A. Becker, H. C. Hottel, and G. C. Williams *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 7–20 17 refs (See N63-18501 17-26)
(Contract DA-19-020-ORD-4549; Grants DA-ORD-31-124-61-G55 and DA-ARO(D)D-31-124-G8)

The aerodynamic flow pattern of a confined, turbulent jet can differ profoundly from that of a free jet, most pronouncedly so in the massive recirculation of downstream gases which occurs under the operating conditions of many industrial furnaces. This paper reports on a study of furnace mixing patterns as represented in the cold by a round jet of oilfog-marked air issuing axially into a cylindrical duct fed by a uniform stream of clear air. Investigation of the fields of mean and fluctuating concentration was made possible by applying the recently developed scattered-light technique of illuminating the space-point of interest with a strong light beam and measuring the intensity of 90°-scattered light. The technique has been refined to the point where the signal can be representative of a cubical volume element as small as 0.5 mm on a side. Emphasis was on the aerodynamic flow regime in which appreciable recirculation occurs. A mapping of the field of mean velocity was made with impact tubes. Velocity fluctuations were not measured as such, but indirect evidence was obtained from a mapping of the field of mean static-pressure defect in the jet. The sol-scattered-light technique itself yielded the fields of mean concentration of nozzle fluid, $\bar{\gamma}$, and r.m.s. fluctuating concentration, $(\bar{\gamma}'^2)^{1/2}$; lateral and longitudinal correlation of efficients and spatial scales of concentration fluctuations; and the wave-number spectrum of concentration fluctuations. Author

N63-18523 Pratt and Whitney Aircraft, East Hartford, Conn.
KINETICS OF HYDROGEN-AIR FLOW SYSTEMS. II. CALCULATIONS OF NOZZLE FLOWS FOR RAMJETS
V. J. Sarli, A. W. Blackman, and R. F. Buswell *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 231–240 21 refs (See N63-18501 17-26)

The performance of exhaust nozzles through which highly dissociated gases are accelerated depends greatly on the degree to which these gases are chemically recombined during the expansion process. An analytical method for calculating the

extent of recombination for a specified nozzle contour has been developed from a combination of the chemical kinetic, gasdynamic, and state equations. A computer program has been evolved and used to solve these equations for hydrogen–air combustion products. The solution of these equations leads to the determination of concentrations, temperatures, pressures, and velocities as a function of time or distance for the combustion process and nozzle expansion. To illustrate the use of the computer program, the extent of recombination of hydrogen–air combustion products in a convergent–divergent exhaust nozzle, having a throat diameter of 6.18 inches, was calculated for combustion chamber entrance conditions of pressure 3000 psf, temperature 2000° R, velocity 200 ft/sec, and an equivalence ratio equal to one. The results indicate that the flow freezes at an area ratio of approximately 1.1 in the nozzle convergent section.

Author

N63-18542 California U., Berkeley

CONTRIBUTION TO THE THEORY OF THE STRUCTURE OF GASEOUS DETONATION WAVES

D. B. Spalding *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 417–423 18 refs Supersedes N63-15704 12-13 (See N63-18501 17-26) (NASA Grant NsG-10-59)

The paper presents exact solutions to the equations governing the distributions of temperature, velocity, and pressure in a gaseous detonation wave, for the cases in which the dimensionless volumetric-reaction-rate w: (a) has a concentrated peak near the hot boundary but negligible values elsewhere; (b) obeys the law

$$w = n(\tau - \tau_C)\left\{\left(\frac{\tau - \tau_C}{\tau_H - \tau_C}\right)^{n-1} - \left(\frac{\tau - \tau_C}{\tau_H - \tau_C}\right)^{2n-2}\right\},$$

Where n is a constant, τ is the dimensionless stagnation temperature, and subscript C denotes upstream conditions. Other exact solutions are also discussed. The methods used are analytical and graphical, requiring no high-speed computing facility. The gas is supposed to have a Lewis Number of unity and a Prandtl Number of 3/4; for convenience, its thermodynamic properties are supposed to be those of a perfect gas. It is argued that, although the reaction-rate functions considered do not correspond to the chemical-kinetic properties of any particular detonating gas, studies of the kind presented permit clear perception of most of the important properties of real gaseous detonations.

Author

N63-18543 California U., Berkeley

DETERMINATION OF THE DETONATION WAVE STRUCTURE

A. K. Oppenheim and J. Rosciszewski *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 424–441 20 refs (See N63-18501 17-26)

In order to investigate the influence of transport properties on the coupling between the shock and deflagration that may occur in a steady, plane detonation wave, the structure of the wave has been determined for some specific cases by numerical analysis performed on an IBM 704 computer. After a preliminary check with some representative cases of Hirschfelder and Curtiss, the procedure was applied to detonation in dissociating ozone. Although the agreement with the solutions of Hirschfelder and Curtiss is not perfect, their contention concerning the strong coupling between the shock and deflagration has been essentially confirmed. The ozone computations included the consideration of the variation of transport properties with temperature and the change in the number of moles due to chemical reaction, while the rate of the reaction was described in terms of the best available data on kinetics. For this purpose the reaction rate has been expressed in terms of the quasi-steady-state approximation for the oxygen atom concentration which, with exception to the immediate vicinity of the hot boundary, represents quite accurately the exact chain reaction mechanism of the thermal decomposition of ozone. On this basis, the structure of the "laminar" detonation wave in ozone has been determined for three fundamental models: the coupled-wave, the von Neumann–Doring–Zeldovich model, and the decoupled deflagration wave. The results have been compared from the point of view of the approximation proposed by Spalding. The validity of the continuum treatment has been checked by evaluating the variation throughout the wave of the average number of intermolecular collisions per molecule of product. It appears from this that, although the theory may not be realistic close to the hot boundary, it is certainly quite reasonable in the regime of coupling between the shock and deflagration—the primary objective of our inquiry. In conclusion, it is contended that only a thorough understanding of the so-called "laminar" wave structure can provide proper basis for the assessment of the effects of turbulence and other time-dependent and multidimensional phenomena that may accompany the detonation process.

Author

N63-18545 Göttingen U. (West Germany)

REACTION ZONE AND STABILITY OF GASEOUS DETONATIONS

H. G. Wagner *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 454–460 19 refs (See N63-18501 17-26)

Many experiments have been performed to measure the "thickness" of the reaction zone of gaseous detonations, i.e., the extension of the region where the main part of the chemical reaction takes place. These experiments have shown that at an initial pressure of 1 atm, the zone was too narow to be resolved. Only in spinning detonations using modes close to the fundamental can one obtain a measure of the reaction time. Both spin and the dependence of the detonation velocity on the flow of the burned gas seem to be closely related to the mechanism of stabilization of a detonation. If the reaction rate is increased, rather high modes of fundamental spin frequency can be detected, which seem to disappear in very long tubes. This indicates a rather strong coupling between the burned gas and the reaction zone, the source of energy. The energy involved in the spin vibrations was found to decrease with increasing mode (frequency roughly proportional to n^{-1}). The dependence of the detonation velocity on the flow conditions in the burned gas, also obtained experimentally, points at the coupling between reaction zone and flow in the burned gas. The end of the zone, in which the energy release which propagates the detonation takes place, lies in a region where chemical reaction is not yet finished. Using the conditions for flow through Mach-number 1, while taking into consideration heat addition, change of the effective tube area by boundary layer and the influence of expansion waves from the wall, etc., and applying it to the velocity deficit of the real detonation, one can get an estimate of the state of chemical reaction at the area where M = 1. This area seems to be rather sensitive to disturbances. In order to investigate the chemical reaction in the main part of the reaction zone, low pressure detonations were used. In overdriven detonations, where the stabilization effects mentioned above are rather unimportant, the reaction zone was fairly smooth. The conditions of normal detonations had to be chosen very carefully in order to obtain regular signals. In some hydrocarbon-O_2 systems, density gradients were determined. In the system H_2-O_2-N_2 density gradients, temperatures, OH-concentrations, etc., were measured. The temperatures at the "end of the reaction" zone agreed with calculated temperatures within

the limits of experimental error. Density, temperature and OH-concentration distribution correspond in principle to the model of Doering, von Neumann and Zeldovich. The chemical reaction, immediately following the shock front in H_2-O_2-N_2 mixtures could be described using the known kinetic data of the H_2-O_2 reaction. Author

N63-18550 Michigan U., Ann Arbor
STANDING DETONATION WAVES
J. A. Nicholls *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 488–498 19 refs (See N63-18501 17-26)
(Contract AF 49(638)-562)

It has long been realized that gaseous detonation waves are capable of propagating at high supersonic or even hypersonic velocities. This characteristic arises from the fact that the associated shock wave must elevate the unburned gas to a temperature sufficiently high that the chemical reactions can occur rapidly. The meaning of "rapidly" in this sense is that the length of the reaction zone must not be long compared to a characteristic dimension of the system. The usual method of studying such phenomena is through the use of flame tubes or shock tubes wherein the detonation wave propagates at the high velocities mentioned. In recent years, a few groups have reported in the open literature the results of experiments directed to the study of standing or stabilized detonation waves (SDW). Such a wave can be attained (maintained stationary relative to laboratory coordinates) when a combustible mixture is accelerated to the appropriate velocity, pressure, and temperature conditions and then subjected to a shock wave. The ensuing complicated phenomena can vary somewhat between different experimental environments and from similar results obtained in shock tubes. Accordingly, it is well to be able to understand the reasons for these differences so that the shock-combustion wave can be better understood and thus the possible utility of the SDW technique evaluated. It is the purpose of this paper to examine the reported results on SDW as obtained in different facilities and compare them. Comparison will also be made with results obtained from shock tubes and a ballistic range. Towards this end, it will be instructive to consider the ignition delay period, the effects of vibrational relaxation, and the importance of two-dimensional effects. Author

N63-18552 Naval Ordnance Lab., White Oak, Md.
THE SHOCK-TO-DETONATION TRANSITION IN SOLID EXPLOSIVES
S. S. Jacobs, T. P. Liddiard, Jr., and B. E. Drimmer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 517–529 36 refs (See N63-18501 17-26)
(Supported by AEC)

Experiments on shock initiation of cast and pressed explosives are discussed. Plane shocks developed by explosive plane-wave generators, and degraded to desired peak amplitudes by the use of intermediate layers of inert materials, were used to initiate detonation in the test explosive sample. The velocity of the shock in each sample was measured as a function of distance into the explosive and as a function of initial shock amplitude. Initial shock pressures ranged from 28 to 140 kilobars. Explosives discussed are TNT and various cyclotols. Both cast and pressed charges were used. In cast charges other than TNT the shock velocity remained essentially constant for a period of time, the length of which depended on the initial shock amplitude, and then rapidly accelerated to normal, steady-state detonation velocity. In pressed charges it was found that in the rapid rise, the shock velocity temporarily exceeded the steady detonation value, but decayed thereafter to that of the normal steady detonation. In cast TNT the velocity was found to rise to a value intermediate to that of the initial shock and the final detonation, where it persisted for a time before growth to the normal detonation value. The overall results can be explained by a hydrodynamic model in which pressure buildup, due to chemical reaction behind the shock, reinforces the shock front as it proceeds through the charge. On the other hand, the detailed results cannot be explained by thermal reactions in homogeneous domains, but require the concept of hotspot initiation. Author

N63-18553 Sandia Corp., Albuquerque, N. Mex.
SHOCK INITIATION OF GRANULAR EXPLOSIVES PRESSED TO LOW DENSITY
Glenn E. Seay *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 530–535 16 refs (See N63-18501 17-26)
(Supported by AEC)

The dependence of the shock initiation of pressed granular explosives on density of the pressing, interstitial gas in the pressing, grain size of the explosive, and characteristics of the initiating shock is discussed. The validity of applying the hydrodynamic equations for a homogeneous material to an inhomogeneous assembly of particles is examined. Various mechanisms for the initiation of granular explosives are compared in terms of current knowledge. Initiation of low-density explosives is not satisfactorily explained by uniform shock heating of the pressing nor by shock heating of the interstitial gas, as has long been thought. It appears that initiation is dependent on minute shock interactions and resulting spalling and jetting, with initiation occurring in the fine particles of the spall or when the products of spalling or jetting are stagnated at the surface of an intact grain. Several experiments are suggested with plane wave constant pressure shocks replacing the complicated geometry of the usual gap sensitivity test. Other experiments are suggested for studying small-scale details of proposed mechanisms of initiation. Author

N63-18555 Explosives Research and Development Establishment, Waltham Abbey (Gt. Brit.)
THEORY OF INITIATION OF DETONATION IN SOLID AND LIQUID EXPLOSIVES
G. K. Adams *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 545–552 12 refs (See N63-18501 17-26)

The experimentally observed differences in the growth of shock-initiated detonation in liquid and in solid explosives are discussed, with the object of deciding upon a reaction-rate model for numerical calculations on the growth of reactive shock waves in granular solid explosives. It is suggested that while a strongly temperature-dependent bulk reaction-rate model is indicated for liquids and homogeneous solids, the behavior of granular solids indicates a reaction rate which is a function of the pressure behind the shock front and not of the average temperature. A pressure-dependent energy-release rate is shown to result in the reaction building up at the shock front rather than at the explosive–barrier interface. Under this condition, it is possible to attempt approximate analytical solutions of the reactive shock equations which illustrate the relation between the initial growth or failure behavior of the wave and the initial shock pressure, shock curvature, and the rate of energy release and its pressure dependence. A pressure-dependent energy-release rate is shown to be a consequence of a grain burning model for the reaction process, where the rate of propagation from ignition surfaces is assumed to be a function of the pressure and flame temperature of the products of reaction. Author

N63-18567 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.
THEORY OF TRANSPORT PROPERTIES OF GASES
E. A. Mason (Maryland U. Inst. for Molecular Physics) and L. Monchick *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 713–724 23 refs (See N63-18501 17-26)
(Supported by NASA and Navy)

This paper reviews recent theoretical work, some still in progress, on the transport properties of gases, with emphasis on those aspects which may be of importance in connection with flame processes. The classical Chapman–Enskog theory of gaseous transport properties is strictly valid only for molecules interacting with a simple central force law, and undergoing only elastic collisions. Real gases can differ from this ideal model in at least three important respects: (1) Free radicals and valence-unsaturated atoms, such as occur in partially dissociated gases, can interact along a family of force laws rather than along a single force law, each force law corresponding to a different alignment of the electron spins as the atoms approach. (2) Real molecules usually have force laws which depend on the relative orientation of two molecules, and so are angular-dependent and not central forces. This is especially pronounced for polar gases. (3) Diatomic and polyatomic molecules can undergo inelastic collisions and interchange molecular energy. This affects the heat conductivity particularly strongly. Author

N63-18576 Cornell U., Ithaca, N.Y.
MAGNETO-FLUID-DYNAMIC NOZZLE FLOW
W. R. Sears, A. R. Seebass, and S. G. Rubin *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 827–832 15 refs (See N63-18501 17-26)
(Supported by AFOSR)

Studies are reported here of both crossed-field and aligned-field channel flows to ascertain whether and under what conditions the various transitions between elliptic and hyperbolic behavior can be crossed smoothly in steady flow and whether such nozzle and diffuser flows are stable to propagating disturbances. Within the limits of various necessary approximations, it is concluded (1) that smooth transitions occur in steady flow provided that choking at the speed of sound is avoided by meeting necessary design conditions, (2) that the resulting nozzle flows are stable to sufficiently small disturbances, (3) that aligned-field diffusers are unstable at the speed of sound and may also be unstable at the Alfvén speed, and (4) that crossed-field diffusers are generally unstable at a critical supersonic speed but may be stabilized by a divergence of area and the presence of a strong magnetic field. Author

N63-18582 International Flame Research Foundation, Ijmuiden (Netherlands)
MODELING OF DOUBLE CONCENTRIC BURNING JETS
J. M. Beér, N. A. Chigier, and K. B. Lee *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 892–900 9 refs (See N63-18501 17-26)

The mixing in a furnace and cold model has been determined from measurements of gas concentrations and velocity distributions and the enclosed double jet has been reduced to its three component parts: the primary, secondary, and recirculated fluids, with the aid of tracer techniques. Good agreement was found between the mixing patterns in the furnace and in the cold model when the nozzle diameters in the model were distorted according to the modified Thring-Newby similarity criterion. The similarity of mixing in the region close to the burner, however, required also that the mass ratio of the primary to the secondary fluids should be maintained the same in the model as in the furnace. Buoyancy in the furnace was found to affect the mixing pattern near the burner when the gravitational forces were large compared with the inertia forces. Experimental evidence suggests that for these cases a dimensionless group, the Archimedes number, should be considered in addition to the above-mentioned modeling criteria. Author

N63-18589 Sheffield U. (Gt. Brit.)
FLOW PATTERNS IN A PHASE CHANGE ROCKET COMBUSTION MODEL
R. B. Hern, R. G. Siddall, and M. W. Thring *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 965–972 3 refs (See N63-18501 17-26)

A phase change giving a density change of the same order of magnitude as that which occurs between the injector face and the exit nozzle of an actual liquid rocket combustor is obtained by flashing hot kerosene in a vertical tube. With single jets, flow patterns are identified and recorded photographically for different values of the inlet parameters and the physical dimensions. All flow patterns are symmetrical about the tube axis, except for a swinging jet, which may be produced under certain conditions. A pair of impinging jets and a pair of parallel jets are also investigated. It would appear that in the case of the impinging jets, droplets from either jet may pass through the plane of impingement and out of the jet pair of the opposite side. These droplets are then observed in the recirculating vapor flow. By increasing jet momenta, both the impinging and parallel jets can be made to produce flow patterns which are very similar. In the model, evaporation is controlled by the kerosene vapor pressure exceeding the local static pressure. A residence time effect on the quantity of material evaporated is evident. The model does not permit quantitative relationships to be developed that can be used for rocket engine design but nevertheless permits the identification and recording of several flow regimes. Author

N63-18639 General Electric Co. Space Sciences Lab., Philadelphia, Pa.
SOME SPHERE DRAG MEASUREMENTS IN LOW DENSITY SHOCK TUNNEL FLOWS
R. E. Geiger July 1963 25 p 13 refs
(Contract AF 04(695)-76)
(R63SD23)

The free-flight technique was extended to low-density flows to measure sphere drag at approximately Mach 15, over a free-stream Knudsen number range of .0027 to .25. Comparison of the data obtained with those of other investigators indicates that: (1) the free-flight technique is useful for shock-tunnel measurements of aerodynamic forces in noncontinuum flows; (2) there is little to choose from between Kn_∞, Re_∞, Re_2 as a correlating variable for experimental sphere drag coefficients; (3) the parameter $C_D - C_{D_i}/C_{D_{fm}} - C_{D_i}$ yields a useful correlation of sphere drag over a wide range of Mach numbers, Reynolds number, and wall temperatures. Author

N63-18686 Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge
THE INCLUSION OF MATERIAL STRENGTH IN HYDRODYNAMIC CALCULATIONS
Walter Hermann, Arfon H. Jones and John H. Percy Kirtland AFB, N. Mex., Res. Directorate, Apr. 1963 94 p 53 refs
(Contract AF 29(601)-4601)
(ASRL-TR-106.1; AFSWC-TDR-63-12)

Inclusion of material strength requires a full thermodynamic treatment, which has not been satisfactorily formulated. An approximation is considered in which entropy production due to plastic flow is neglected. In the resultant theory, stresses are related to elastic strains through an isentropic-strain energy potential, and the elastic strains are limited by a

yield condition. Results of an analysis of dynamic compressibility data for copper to 2.7 Mbar by second-order elasticity theory are very encouraging. Analysis of experimental plane-wave-propagation data for aluminum with a variety of yield functions indicates that presently measurable quantities do not provide a sensitive means of determining the yield function. Author

N63-18727 Royal Inst. of Tech., Stockholm (Sweden)
AN ATTEMPT AT A ONE-DIMENSIONAL TREATMENT OF THE FLOW IN A HALL-EFFECT MHD-GENERATOR CHANNEL
Erling Dahlberg 1963 25 p 6 refs
Uts Trans. No. 208; Pure and Appl. Math. and Phys. 23)

Steady flow of a conducting gas in crossed, longitudinal electric, and transverse magnetic fields is treated. The conductivity is taken as the scalar conductivity multiplied by a Hall-effect tensor. Owing to the complexity of the two-dimensional problem, a one-dimensional treatment is considered worth developing. In this, the invariance along the channel of mass flow and longitudinal current are taken into account. Author

N63-18734 General Tech. Corp., Torrance, Calif.
BASIC MECHANISMS OF NONCONDENSABLE GAS CRYOTRAPPING
Arnold Eng. Develop. Center, July 1963 66 p 7 refs
(Contract AF 40(600)-941)
(AEDC-TDR-63-147)

Systematic measurements are reported on the rate at which argon and nitrogen are trapped by water as it condenses under vacuum onto a 77° K surface. For condensation rates between 10^{15} and 10^{18} molecules per cm^2-sec and noncondensable partial pressures between 10^{-6} and 10^{-1} torr, trapping rates are proportional to condensation rate and a concentration of adsorbed gas. The latter are described by Langmuir isotherms with characteristic pressures for saturation of 2.5×10^{-3} torr and 3×10^{-3} torr for nitrogen and argon, respectively. Independent adsorption measurements show that quantity of gas adsorbed is proportional to mass of condensate ($\sim$600 meters^2 per gram) and depends on pressure identical with the trapping. "Apparent trapping" due to adsorption on surface area generated during condensation is only about 7% of actual trapping. All the results are consistent with a mixed phase for the condensate, of which approximately 10% is the 12A gas hydrate. Rates for the trapping of hydrogen and helium by water and nitrogen by 1-nitropropane were below the limits of detection for the equipment in use; upper bounds are given for these cases. Supplementary measurements, included in an appendix, show that the solubility of air in 1-nitropropane at normal atmospheric conditions is about 70 times that of water. Author

N63-18735 Mississippi State U., State College
MEAN VELOCITY DISTRIBUTION IN THE OUTER LAYER OF A TURBULENT BOUNDARY LAYER
Tatsuya Matsui Jan. 19, 1963 45 p 17 refs
(Contract Nonr-978(03))
(Res. Rept. 42)

The intermittent-eddy-viscosity hypothesis is proposed for the outer layer in a turbulent boundary-layer flow, and it assumes an alternate appearance of zero eddy viscosity in the nonturbulent region and of a constant eddy viscosity in the turbulent region. The equation-of-motion is simplified by assuming the velocity defect law and that the velocity defect is small compared with the free-stream velocity. With these assumptions, the distributions of mean velocity and shear stress in the outer layer of a turbulent boundary layer on a flat plate for constant pressure are obtained using the intermittency factor measured by Klebanoff. The calculated results show good agreement with those measured. Author

N63-18745 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
THEORETICAL AND EXPERIMENTAL STUDIES OF IMPINGING UNIFORM JETS Technical Report [Dec. 1961-Dec. 1962]
W. Gordon Brady and Gary R. Ludwig Ft. Eustis, Va., Army Transportation Res. Command, Apr. 1963 116 p 19 refs
(Contract DA-44-177-TC-782)
(CAL-BB-1657-S-1; TRECOM-TR-63-11)

The purpose of the theoretical and experimental study reported herein was to investigate the flow characteristics of circular uniform jets impinging normally on a ground plane, in order to further the understanding of the aerodynamic processes associated with ground particle entrainment in the impinging downwash of VTOL aircraft. Particular emphasis was placed on the flow properties in the ground-plane boundary layer where entrainment occurs. On the basis of the investigation that was conducted, general conclusions were drawn and are presented. Author

N63-18750 Boeing Scientific Research Labs., Seattle, Wash.
ON THE ACCELERATION OF MAGNETOGASDYNAMIC CHANNEL FLOWS THROUGH THE SONIC VELOCITY
F. D. Hains Mar. 1963 83 p 5 refs
(DI-82-0239; Flight Sciences Lab. TR-72)

The possibility of passage through the sonic velocity is examined for the magnetogasdynamic flow through a diverging, straight-walled channel. In addition to the usual assumptions of continuum MGD, the electrical conductivity is assumed to be small, but the effect of Hall current is included. A number of different cases arise, depending on whether or not one or more parameters vanish or are small. Numerical results for the case where the Hall current vanishes, and the problem becomes analogous to the gasdynamic source, indicate the sonic point can be placed anywhere along the channel by proper selection of the electric and magnetic-field strengths and boundary conditions. Author

12 GEOPHYSICS

Includes: auroral phenomena; upper atmospheric studies; cartography; geodesy; and geomagnetism.

For Van Allen belts see: 28 Space Radiation.

For related information see: 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

N63-18305 Centre National d'Etudes des Télécommunications (France)
STUDY OF THE IONOSPHERE BY A VERY LOW FREQUENCY METHOD BY MEANS OF ROCKETS OR SATELLITES. PRINCIPLE OF MEASUREMENTS, DETERMINATION OF PARAMETERS, CHARACTERISTICS OF EQUIPMENTS [ETUDE DE L'IONOSPHERE PAR UNE METHODE TRÈS BASSE FRÉQUENCE AU MOYEN DE FUSÉES OU DE SATELLITES. PRINCIPE DES MESURES, DETERMINATION DES PARAMÈTRES, CARACTÉRISTIQUES DES ÉQUIPEMENTS]
M. R. Clauvel and M. C. Renard [1962] 56 p 8 refs In FRENCH
(Étude-671-TC)

After a brief review of the theory of wave propagation according to the whistler mode, a method for measuring the parameters (index of refraction and local electron density) of the ionosphere is presented. This method is as follows: (1) Continuous waves of very low frequency are sent from a ground station to a rocket or satellite. (2) The signals are received by three loop antennas (where the waves are surrounded by a magnetic field) by two dipoles (where the waves are surrounded by an electric field), and by other associated receivers. (3) The signals are analyzed and retransmitted to the ground station by means of telemetry. The signals received, the precision of the measurements, and the particular characteristics of the antennas and receivers employed permit an evaluation of the restitution of the ionospheric parameters. This evaluation in turn can be used in determining the suitable payload and in selecting the type of rocket or satellite most suitable for ionospheric sounding. Trans. by I.v.L.

N63-18326 Servicio Meteorologico Nacional, Madrid (Spain)
THE IONOSPHERE [IONOSFERA]
Madrid, Ministerio del Aire, 1962 333 p In SPANISH
(*Its* Publ. Ser. D (Estadisticas) No. 19; Obs. del Ebro Boletin v. 46, 1958)

Tables of ionospheric data are presented for the year 1958. The observations were made at the Ebro Observatory in Spain, at geomagnetic coordinates of 79° 7′ longitude and N 43° 9′ latitude. The frequencies of the observations were from 1.4 to 16.6 megacycles—from 1.4 to 3.3 mc, from 3.3 to 8.4 mc, and from 8.4 to 16.6 mc. Also included are monthly indices of solar magnetic and electrical activity during 1958. Trans. by D.E.R.

N63-18335 Geophysics Corp. of America, Bedford, Mass.
STUDY OF WINDS, DIFFUSION, AND EXPANSION OF GASES IN THE UPPER ATMOSPHERE Final Report
Oct. 1962 135 p 6 refs
(NASA Contract NAS5-215)
(GCA-TR-62-13-N) OTS: $10.50 ph, $4.25 mf

The major objectives of this project are the measurement of upper winds and diffusion by using sodium vapor as a trace element. The accomplishments during this period may be summarized as follows: (1) Wind data from all Nike-Asp and Nike-Cajun flights have been reduced. A detailed analysis of this data and that from more recent flights is continuing in order to detect evidence of cyclic trends and large-scale patterns. (2) Techniques for determining diffusion coefficients have been developed to the extent that reproducible and consistent diffusion data have been obtained from trail releases to about 250 km and from point releases at 400 km. Measurements to determine temperature were made on the 400 km releases. (3) Atmospheric turbulence in the region around 100 km has been investigated through a study of growth of sodium trails. (4) The expansion of clouds of released vapor at altitudes of 400 and 650 km have been analyzed both experimentally and theoretically. It was found that concepts of classical fluid dynamics can describe the growth and structure of these clouds. (5) Improved reliability has been built into the rocket-borne firing circuits and vaporizer ignition system. No failures have occurred in over 40 successful inflight ignitions with the new system. (6) A technique for the use of lithium as a major element in the vaporizer was developed. N.E.A.

N63-18375 Southwest Center for Advanced Studies, Dallas, Tex.
DYNAMIC DIFFUSION PROCESSES IN THE EXOSPHERE
W. B. Hanson Apr. 26, 1963 22 p 12 refs Presented at the NATO Advanced Study Inst. on Electron Density Profiles in the Ionosphere and Exosphere Submitted for Publication
(NASA Grant NsG-269-62)
(NASA CR-50417) OTS: $2.60 ph, $0.86 mf

The constrainment of both ionized and neutral particles in the entire magnetosphere by ion-ion diffusion processes which take place in the upper F-region is reviewed. Calculations show that the effect of the whistler medium in acting as a giant hydrogen capacitor, storing hydrogen as protons in the daytime and releasing them at night as atomic hydrogen, is probably too small to be of importance in affecting the diurnal distribution of atomic hydrogen. Also, it appears unlikely that the ionization transport between hemispheres through the magnetosphere can greatly influence the electron concentrations near the F_2-peak. It is suggested that the energy-sensitive coulomb diffusion process may affect the exospheric ion concentrations by a "greenhouse" mechanism. I.v.L.

N63-18406 Iowa State U., Iowa City
DEFORMATION OF MAGNETIC SHELLS DURING MAGNETIC STORMS
S.-I. Akasofu (Geophysical Inst., College, Alaska) May 1963 29 p 16 refs
(NASA Grants NsG-233-62 and NsG-201-62)
(NASA CR-50061; SUI 63-16) OTS: $2.60 ph, $1.07 mf

The nature of the distortion of the earth's magnetic field in the radiation belt regions is studied for the combination of two external sources, namely, the ring current and the solar plasma flow. The distortion is expressed by diagrams showing the location of two points on the distorted lines of force, namely, the radial distance r_e of a point at which the line-of-force crosses the equator and its anchoring latitude ϕ (or $L = 1/\cos^2 \phi$) on the earth's surface. The $r_e - \phi$ (or $r_e - L$) diagrams thus constructed are of use in studying the deformations of the outer radiation belt. Author

N63-18409 RAND Corp., Santa Monica, Calif.
SOME SATELLITE ORBITS FOR THE WORLD MAGNETIC SURVEY
D. W. Stebbins May 1963 32 p 9 refs
(NASA Contract NASr-21 (05))
(NASA CR-50474; RM-3536-NASA) OTS: $3.60 ph, $1.16 mf

This memorandum considers the coverage of the magnetic field and particle belts around the earth that might be provided by several suitably instrumented satellites orbiting within a shell having an inner radius of approximately 6878 kilometers (500 km above the earth's surface) and an outer radius of approximately 14 earth radii. Within this shell probably occur most of the solar-induced variations in the magnetic field and particle populations. Author

N63-18418 California U., La Jolla
ABUNDANCES OF THE NOBLE GASES IN THE ATMOSPHERE AND IN METEORITES
H. E. Suess Repr. from Nuclear Geophys. Washington, NAS-NRC, 1963 p 161–166 3 refs Proc. of Conf. on Nuclear Science, Woods Hole, Mass., June 7–9, 1962
(NASA Grant NsG-322-63)
(NASA CR-50315; Nuclear Sci. Ser. Rept. 38; Publ. 1079)

The abundances of the noble gases in the earth's atmosphere and in meteorites are reviewed. Fractionation curves show that there is ~10,000 times more neon in the earth's atmosphere than there is xenon which means that a very effective separation of neon and xenon took place. The other gases, argon and krypton, lie between neon and xenon on a remarkably smooth curve. Also, it is indicated that the noble gases in the atmosphere did not come from outgassing of the mantle. Abundances of noble gases in chondritic meteorites, such as the Bruderheim meteorite, are very similar to those found in the earth's atmosphere. I.v.L.

N63-18419 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
FREE OSCILLATIONS OF A GRAVITATING SOLID SPHERE
Russell E. Carr Sept. 25, 1961 34 p 8 refs
(NASA Contract NASw-6)
(NASA CR-50654; JPL-TR-32-164) OTS: $3.60 ph, $1.22 mf

The problem of determining the free oscillations of a gravitating solid sphere is investigated. The problem itself is formulated and, with the assumption of radial symmetry in the structure of the sphere, the numerical solution for the case of the toroidal oscillations is described in detail. A formal description is given to indicate the numerical solution of the problem of the spheroidal oscillations. Author

N63-18440 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
DETERMINING THE DENSITY OF THE UPPER ATMOSPHERE BY MEANS OF THE DIFFUSION OF SODIUM VAPOR
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 102–105 (See N63-18430 17-32)

A method is developed for determining the density of the upper atmosphere by means of the diffusion of sodium vapor. This method utilizes the phenomenon of the artificial radiation by certain gases of individual spectral lines and bands. A sodium cloud which scatters the sun's rays is an exceptionally powerful source of light. A 1-kg mass of sodium vapor has a power of about 700 kilowatts. An invaluable advantage of a sodium cloud is that it scatters light of a strictly defined wavelength $\lambda = 0.589$. This method was verified experimentally by a geophysical rocket sent aloft at 430 km. J.R.C.

N63-18441 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
MASS-SPECTROMETER MEASUREMENTS OF THE ION COMPOSITION OF THE UPPER-ATMOSPHERE
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 111–113 (See N63-18430 17-32)

Mass spectrometer measurements of the ion composition of the upper atmosphere were made using a radiofrequency mass spectrometer. The mass spectrometer used was designed to record ions with mass numbers of 6 to 50. Measurements were made in the period 15 to 25 May 1958 and were at heights ranging from 225 to 980 km. The data showed that at 225 to 980 km the most intense ion is the peak with mass number 16—an ion of atomic oxygen. The second most intense ion is that with a mass number of 14—an ion of atomic nitrogen. J.R.C.

N63-18442 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
INVESTIGATION OF THE IONOSPHERE: A STUDY OF THE PROPAGATION OF RADIO WAVES IN THE IONOSPHERE, THE EXTENT OF THEIR ABSORPTION, AND DETERMINATION OF IONIZATION OF THE UPPER ATMOSPHERE
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 114–119 (See N63-18430 17-32)

A study is made of the propagation of radio waves in the ionosphere, the extent of their absorption, and determination of ionization of the upper atmosphere using data obtained from a satellite. The results of measuring the field strength of the radio signals permit estimating the absorption of radio waves in the ionosphere, including those regions which lie above the main maximum of ionization of the ionosphere of the F-2 layer. J.R.C.

N63-18458 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ENERGETIC PARTICLES IN THE INNER VAN ALLEN BELT
Wilmot N. Hess Washington, NASA, July 1963 40 p 71 refs
(NASA TN D-1749) OTS: $1.25

A survey is given of the high-energy particle populations in the inner radiation belt. The experiments which have given information about particles are discussed, and the best experimental information about particle fluxes and spectra is presented. Calculations are given which indicate what particle sources and loss processes are most important. The role of neutrons in making the inner belt is considered in detail, and the need for particle acceleration and/or other sources of particles is shown. Author

N63-18472 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THEORETICAL DETERMINATION OF THE FORM OF THE HOLLOW PRODUCED IN THE SOLAR CORPUSCULAR STREAM BY INTERACTION WITH THE MAGNETIC DIPOLE FIELD OF THE EARTH
John R. Spreiter and Benjamin R. Briggs Washington, GPO, 1961 29 p 16 refs
(NASA TR R-120) GPO: $0.40

The interaction between a neutral stream of ionized solar corpuscles and a three-dimensional magnetic dipole representing the geomagnetic field is investigated. It is assumed that the stream is confined to the exterior and the magnetic field to the interior of a hollow, the boundary of which is defined by a thin current sheath. An approximate method of solution is applied, and results are presented for the coordinates of the trace of the boundary of the hollow in the meridian plane containing the sun–earth line and the dipole axis for several relative orientations. Results are also presented for the trace in the equatorial plane for the case in which the dipole axis is normal to the sun–earth line. The corresponding problem in two dimensions is also considered, and it is shown that the analogous approximate results are in good agreement with the results indicated by an exact solution of the same basic equations. Author

N63-18474 Chicago U., Ill.
MECHANISMS OF AURORAL RADIATION
C. Y. Fan *In* Chicago U. Labs. for Applied Sciences, Ill. Symp. on Background Radiation. Ultraviolet, Visible, and Infrared Levels and Distributions (Spring 1962) Apr. 1963 p 2–15 1 ref (See N63-18473 17-12)

In this report, laboratory experiments on auroral excitation are reviewed. It is shown that spectra excited by low-energy particles exhibit the characteristics of the species of the particles which do the excitation, thus enabling us to identify two components of auroral particles, electrons, and protons. Theories on the origin of the particles are also briefly discussed. Author

N63-18475 Chicago U. Labs. for Applied Sciences, Ill.
SUMMARY OF LAS CALCULATIONS ON AURORAL RADIATIONS IN THE INFRARED
H. A. Brown *In its* Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions Apr. 1963 p 16–19 (See N63-18473 17-10)

This paper contains tables showing the relative intensities of transitions between energy states in the auroral radiation bands, and the relative populations of the excited states. A complete table for the Meinel bands is also given. P.V.E.

N63-18476 Chicago U. Labs. for Applied Sciences, Ill.
PRESENT AND FUTURE PLANS FOR MEASUREMENT OF AIRGLOW, AURORA, AND CHEMILUMINESCENCE
Lucien M. Biberman *In its* Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 20–33 7 refs (See N63-18473 17-10)

This paper enumerates the current plans in auroral and airglow measurements including POGO and related research satellites and probes. A section of a preliminary paper by James E. Milligan and Theodore P. Stecher entitled "Observational Astrophysics From Rockets: Stellar Spectra," is also included. Author

N63-18486 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PRELIMINARY INVESTIGATION OF THE MEASURED ATMOSPHERIC EFFECTS UPON SOUND PROPAGATION
Richard N. Tedrick and Robert C. Polly Mar. 24, 1963 23 p 9 refs
(NASA TM X-50142; MTP-TEST-63-6) OTS: $2.60 ph, $0.89 mf

To protect the surrounding communities from the high-intensity noise fields which are produced during the static test firing of large space vehicles, the effects of atmospheric changes upon acoustic propagation have been investigated. Since the net effect of changes in the temperature and wind parameters is to change the velocity of sound distribution with altitude, these changes also result in variations of sound pressure level beyond one kilometer. The types of possible velocity of sound versus altitude profiles are categorized. The characteristic sound-pressure-level distribution for each category is illustrated and discussed. Also discussed are observed seasonal variations in measured sound-pressure level under certain meteorological conditions. Measured data are presented showing the effects of molecular absorption upon low-frequency acoustic propagation. Author

N63-18670 International Geophysical Year World Center A, National Academy of Sciences, Washington, D.C.
UNITED STATES IGY BIBLIOGRAPHY 1953-1960. AN ANNOTATED BIBLIOGRAPHY OF UNITED STATES CONTRIBUTIONS TO THE IGY AND IGC (1957-1959)
Frank M. Marson and Janet R. Terner, comps. (Library of Congress) Apr. 1963 301 p 2853 refs
(Sponsored by National Sciences Foundation)
(IGY Gen. Rept. Series 18; Publ. 1087) NAS: $3.00

N63-18681 Alaska U. Geophysical Inst., College
HYDROMAGNETIC INTERPRETATION OF SUDDEN COMMENCEMENTS OF GEOMAGNETIC STORMS Scientific Report No. 3
Charles R. Wilson May 1963 174 p 83 refs
(Contract AF 19(604)-7988)
(VAG-R135; AFCRL-63-605)

A new hydromagnetic model for the sudden commencement (SC) of a magnetic storm is presented. The model is based on a new morphology of the SC field that was derived from an analysis of the characteristics of vector diagrams for the first few minutes of the SC field variation. The most characteristic feature of the SC field is the polarization of the field that is due to a combination of circularly and linearly polarized components. The variation of the SC field over the earth is described in terms of the variations with local time and latitude of the direction of polarization (i.e. clockwise or counterclockwise) and initial phase of the circularly polarized component and the ratio of the amplitudes of the two components. The two polarized components of the SC field are identified as circularly polarized transverse and linearly polarized longitudinal hydromagnetic waves. The longitudinal wave is the immediate consequence of the impact of a solar plasma cloud on the magnetosphere; whereas the transverse wave is produced by a coupling with the longitudinal shock wave in the magnetosphere. The triply refracting nature of the plasma in the magnetosphere results in the production of three hydromagnetic modes by the SC disturbance; namely, ordinary and extraordinary transverse waves with opposite directions of circular polarization which propagate to high latitudes in the morning and evening hemispheres, respectively, and longitudinal waves which propagate to the earth in low latitudes. Author

N63-18722 Aeronutronic, Newport Beach, Calif.
INFRARED TRANSMISSION STUDIES. VOLUME V: TRANSMITTANCE TABLES FOR SLANT PATHS IN THE STRATOSPHERE Final Report
Gilbert N. Plass May 22, 1963 295 p 6 refs
(Contract AF 04(695)-96)
(SSD-TDR-62-127, Vol. V)

Tables are given for the transmittance over slant paths from initial altitudes of 15, 25, 30, and 50 km to the outer limit of the atmosphere. Values are given for all angles, from vertical to horizontal, in 5° steps. Results are presented for CO_2 from 500 to 10,000 cm^{-1} and for H_2O from 1000 to 10,000 cm^{-1} for both a "dry" stratosphere (uniform mixing ratio) and a "wet" stratosphere (mixing ratio increasing with height). The calculations are based on previously published transmittance tables for homogeneous paths and theoretical expressions for obtaining slant-path transmittances from such results. Author

N63-18726 Hi-Altitude Instrument Co., Inc., Golden, Colo.
A REPORT OF SKY LUMINANCE AND SOLAR LUMINANCE DATA FROM SOLAR TANDEM BALLOON FLIGHTS, 17 MAY 1962 Scientific Report No. 1
Alfred A. Goddard, Jr. Feb. 1963 30 p
(Contract AF 19(604)-7472)
(AFCRL-63-617)

The results of two balloon flights, 50 minutes apart, to obtain solar and near-sun sky-luminance data as a function of altitude are given. Luminances as a function of time are also given for both flights at the float altitude of 84,000 ft. These data were obtained in the broad spectral region from 400 to 800 millimicrons, using CdS detectors. Author

N63-18736 Electronic Associates, Inc. Research and Computation Div., Princeton, N.J.
EXPLORATORY PROGRAMMING STUDIES FOR IONOSPHERIC RAY TRACING Final Report
Ray Beadle, Paul Landauer et al Oct. 8, 1962 52 p 1 ref
(Contract AF 19(604)-7294)

The work performed was the development of preliminary analog-computer programs for the solution of the two-dimensional electromagnetic ray path equations. The system equations were simplified and simulated to obtain information on the ranges of the variables and to locate any preliminary difficulties. The information obtained was then applied to develop improved programs for the more complex cases, until the complete two-dimensional simulation of the ray path equations was accomplished. The results of this study show that the electromagnetic ray path equations could be satisfactorily simulated, employing the general purpose analog computer. Furthermore, the polar coordinate system of equations was the more desirable form to simulate. Author

N63-18737 Boeing Scientific Research Labs., Seattle, Wash.
ON THE ASSOCIATION OF THE VARIATION OF COSMIC RAYS IN HIGH LATITUDES WITH SOLAR ACTIVITY AND GEOMAGNETIC DISTURBANCES
A. I. Ol' Transl. into ENGLISH from Trans. Arctic and Antarctic Sci. Res. Inst. (Leningrad), v. 223, 1960 p 110–149 34 refs (Transl. R15)

Observations of the meson intensity of cosmic rays, made at the Tikhaia Bay and Cape Schmidt high latitude observatories, are discussed in the light of determining the variations in this intensity and the relationship of these variations to solar activity and to geomagnetic disturbances. Observations were made with ASK-2 ionization chambers. These chambers have a volume of 50 liters and are filled with argon at a pressure of 36 atm. The chambers are shielded with a 12-cm-thick lead layer. I.v.L.

N63-18752 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
COLLECTION OF GEOPHYSICAL WORKS – 1961 [GEOFYSIKÁLNÍ SBORNÍK – 1961]
Alois Zatopek, ed. 1962 496 p 312 refs In CZECH, RUSSIAN, GERMAN, or ENGLISH
(*Its* Vol. 9, Nos. 146–161) Available from Publishing House of the Czechoslovak Academy of Sciences, Prague: 59 Kčs

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14. THE GEO-ELECTRICAL ANOMALIES OF THE RESISTANCE GENERATED BY A SPHERICAL BODY IN INFINITE HALF-SPACE [GEOELEKTRICKÉ ODPOROVÉ ANOMÁLIE VYVOLANÉ GUĽOVOU VLŽKOU V NEKONEČNOM POLOPRIESTORE] S. Krajčovič (Geophysical Lab. SAV) p 421–439 10 refs (See N63-18766 17-12)

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N63-18753 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
THE GRAVITATIONAL EFFECTS V_z OF BODIES BOUNDED BY PLANES OF SECOND ORDER [DIE SCHWEREWIRKUNGEN V_z VON KÖRPERN, DIE VON FLÄCHEN ZWEITEN GRADES BERGRENZT SIND]
Rostislav Valék and Eduard Stehlík (Karlova U.) *In its* Collection of Geophysical Works—1961 1962 p 9–31 7 refs In GERMAN; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 146)

Transparent gliding plane nomograms are presented for computing the gravitational effects of complex bodies bounded by planes of the second order. The computations cover the following cases: (1) the gravitational effects of three-dimensional bodies bounded by planes of the second order; (2) the gravitational effects of a two-dimensional elliptical cylinder; and (3) the gravitational effects of bodies bounded by parabolic planes. I.v.L.

N63-18754 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
INTERPRETATION OF THE GRAVITY ANOMALIES V_z BY MEANS OF MODELS [INTERPRETATION DER SCHWEREANOMALIEN V_z MITTELS MODELLEN]

Rostislav Valék (Karlova U.) *In its* Collection of Geophysical Works—1961 1962 p 33–62 7 refs In GERMAN; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 147)

The first step in interpreting a measured gravitational anomaly is to draw the characteristic gravitational profile on one, or more, gravimetric paper in order to determine the depth of the disturbing body. The second step is to obtain the dimensions of the body through the use of a respective transparent gliding plane nomograph. It is possible, using these two steps, to obtain information about the position and the dimensions of the anomalous body in a very few minutes. In the third step, a more exact interpretation of the concept of the disturbing body is obtained by solving the so-called "converse problem" by means of nomographs with transparent gliding planes. I.v.L.

N63-18755 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
DETERMINATION OF THE ERRORS OF REPRESENTATION OF THE BOUGUEROVYCH ANOMALY IN THE REGION OF CZECHOSLOVAKIA [ODVOZENÍ CHYBY Z INTERPOLACE BOUGUEROVÝCH ANOMÁLIÍ NA ÚZEMÍ CĚCH]
Milan Bürsa (Inst. of Geodesy, Cartography, and Topography) *In its* Collection of Geophysical Works—1961 1962 p 63–76 13 refs In CZECH; GERMAN and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 148)

Gravitational interpolation errors of the anomaly and the degree of the anomaly of the gravitational fields are presented in conjunction with investigations of the Bouguerovych anomaly for two areas in Bohemia. I.v.L.

N63-18756 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
TOPOGRAPHIC-ISOSTATIC CORRECTIONS FOR THE ZONES 18-1 IN THE TERRITORY OF THE CZECHOSLOVAK SSR [TOPOGRAFICKO-ISOSTATICKÉ OPRAVY ZÓN 18-1 PRO ÚZEMÍ CSSR]
Vincenc Vyskocil *In its* Collection of Geophysical Works—1961 1962 p 77–82 8 refs In CZECH; GERMAN and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 149)

The effect of remote topographic and compensating masses in Czechoslovakia is investigated. Maps are presented of the topographic and topographic–isostatic corrections of the Hayford zones, 18 to 1, for the isostatic system according to Airy–Heiskanen where T = 20, 30, 40, and 60 km. The plus and minus signs of these corrections are chosen in such a manner that the data taken from the maps can be directly added to the measured gravitational anomaly or to the topographic gravitational anomaly. Also, the entire course of topographic–isostatic corrections for all of Europe are established. These maps should serve as a basis for an extensive analysis and explanation of the anomalies of the gravitational fields in Czechoslovakia. I.v.L.

N63-18757 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
UTILIZATION OF A PUNCH-CARD SYSTEM FOR INTERPRETING GRAVIMETRIC OBSERVATIONS [VYUŽITÍ SYSTÉMU DĚRNÝCH ŠTÍTKŮ PRO VYHODNOCOVÁNÍ GRAVIMETRICKÝCH MĚŘENÍ]
Ivo Bartoněk and Ivan Pola (Geophysical Inst., Brno) *In its* Collection of Geophysical Works—1961 1962 p 83–94 6 refs In CZECH; GERMAN and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 150)

The utilization of a punch card system for the rapid computation of gravimetric measurements is discussed. A comparison of the results obtained by this system and those obtained by office-type calculators indicates that the former gives not only more rapid but also more accurate measurements. I.v.L.

N63-18758 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
ON THE REFLECTION OF IMPULSIVE SPHERICAL WAVES AT A PLANE INTERFACE [OTRAZHENIE SFERICHESKIKH IMPUL'SIVNYKH VOLN OT PLOSKOY GRANITSY RAZDELA]
František Hron (Karlova U.) *In its* Collection of Geophysical Works—1961 1962 p 95–121 45 refs In RUSSIAN; CZECH and ENGLISH summaries (See N63-18752 17-12)
(Paper No. 151)

This paper studies the reflection of impulsive spherical waves at a plane interface between two liquid elastic media. A brief introduction to the problems treated in this work is given, and the basic formulae for the potential of reflected compressional waves are calculated. It was assumed that the potential of an incident spherical compressional impulsive wave is $H(\tau)/R_o$, where $H(\tau)$ is Heaviside's unit function, R_o the distance from the source. The resultant formulae for the potential of a reflected wave before, in, and beyond the critical point are given. Author

N63-18759 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
CONTINENTAL WAVES IN CENTRAL EUROPE
Karel Pěč (Karlova U.) *In its* Collection of Geophysical Works—1961 1962 p 123–192 50 refs In ENGLISH; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 152)

A physical interpretation of *Lg* type waves as normal undamped Love waves propagating with a critical frequency in a layer permits all the properties of these waves, found by observation, to be explained completely. All the dynamic properties of *Lg* waves also naturally follow from the conception of undamped normal waves. The anomalies found for the amplitude curves correspond to changes in the thickness of the whole earth's crust, and also of the individual lithospheric layers composing it. Author

N63-18760 Czechslovak Academy of Sciences. Geophysical Inst., Prague
AN ELECTRONIC APPARATUS FOR PRECISE MEASUREMENT OF THE ELASTIC PARAMETERS OF ROCKS [APPARATURA DLYA TOCHNYKH IZMERENIY UPRUGIKH PARAMETROV GORNYKH POROD]
Zdenek Pros *In its* Collection of Geophysical Works—1961 1962 p 193–228 35 refs In RUSSIAN; CZECH and ENGLISH summaries (See 18752 17-12)
(Paper No. 153)

An electronic apparatus for precise measurement of the elastic parameters of rock samples was developed. Individual blocks of the apparatus are described in detail. The time marks calibrating the time scale are derived from a continuously working quartz-controlled oscillator. The results of calibrating measurements showed the frequency of the basic oscillator to be 999951 ±2Hz, the resolution power on the screen of CRT being 0.02 μs for repeated measurements. Using the method of transmission, a precision of 0.07% in determining the velocity of longitudinal waves can be thus obtained under the usual laboratory conditions. Examples of laboratory measurements of elastic parameters on rock samples under ordinary conditions and uniaxial pressure demonstrate the applicability of the apparatus developed for studying the kinematic and dynamic parameters of elastic waves in rocks. Author

N63-18761 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
FUNDAMENTALS OF A PIEZOPHOTOGRAPHIC METHOD FOR MEASURING THE AMPLITUDE OF PRESSURE WAVES [FRUNDLAGEN DER PIEZOPHOTOGRAPHISCHEN METHODE ZUR MESSUNG DER DRUCKWELLENAMPLITUDEN]
Ludvík Waniek *In its* Collection of Geophysical Works—1961 1962 p 229–310 49 refs In GERMAN; RUSSIAN and CZECH summaries (See N63-18752 17-12)
(Paper No. 154)

A piezophotographic method for measuring the amplitude of pressure waves is described. This method uses the silver halide crystals in the photographic layer as microscopic pressure indicators. These crystals cause a pressure-dependent change in the light sensitivity of the emulsion layer so that the deformation of the crystals can be measured by indirect photography. This new method for measuring the amplitude of pressure waves can be applied to: (1) the classification of explosives; (2) the determination of the absorption coefficients of pressure waves in solid bodies; and (3) the determination of the pressure distribution of contacting surfaces. I.v.L.

N63-18762 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
DETERMINATION OF THE INTENSITY OF SEISMIC SHOCKS BY MEANS OF SIMPLE INSTRUMENTS AND THE RELATION OF THE INTENSITY TO THE MAGNITUDE [INTENSITÄTSBESTIMMUNG SEISMISCHER ERSCHÜTTERUNGEN DURCH EINFACHE INSTRUMENTE UND DEREN BEZIEHUNG ZUR MAGNITUDE]
Alfred Adlung (Lindenberg Aerological Obs.) *In its* Collection of Geophysical Works—1961 1962 p 311–353 35 refs In GERMAN; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 155)

The determination of the intensity of macroseismic shock by experiments with tumbling bodies was investigated. The apparatus used was a vibration table with shock-type excitations. Results indicated that tumbling bodies cannot be used to determine seismic shock intensity because the tumbling moment cannot be determined with sufficient accuracy. The failure of these experiments led to the investigation of a method which permits the determination of shock intensity from the ground amplitude (magnitude) of the shock. In conjunction with this experiment, a vibration meter was devised and tested experimentally. Results indicated that this meter provided accurate measurements of shock intensity. I.v.L.

N63-18763 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
AN INVESTIGATION OF THE SEISMIC INFLUENCE OF EXPLOSIONS ON ORDINARY BRICK BUILDINGS [ÜBER SEISMISCHE EINFLÜSSE VON SPRENGUNGEN AUF ÜBLICHE ZIEGELBAUTEN]
Arnošt Dvorák *In its* Collection of Geophysical Works—1961 1962 p 355–380 5 refs In GERMAN; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 156)

The seismic effects of small explosions on a brick building were investigated. Sealed explosive charges were placed in bore holes at various distances from the building and were set off to simulate seismic shock. Results were as follows: (1) the most severe damage was on the inner transverse walls and ceilings (2 to 3 cm wide continuous cracks) of the second floor during an oscillatory velocity measured at the front wall of this floor. The components of this velocity were a 3 cm/sec longitudinal component, a 1 cm/sec lateral component, and a 3 to 4.8 cm/sec vertical component. (2) Vertical cracking of the main wall of the first floor occurred when the oscillatory velocity reached this floor. These results led to the determination of boundary values at which cracking occurs. These values are a = 90 to 410 cm/sec^2 for the acceleration and K = a^2/n 1000 to 8200 cm^2/sec^3 for the degree of tremor (according to Zeller). I.v.L.

N63-18764 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
PALAEOMAGNETIC CHARACTERISTICS OF SOME ROCKS OF PRE-CAMBRIAN AND PALAEOZOIC AGE IN CZECHOSLOVAKIA AND THEIR MAGNETIC STABILITY
Václav Bucha *In its* Collection of Geophysical Works—1961 1962 p 381–401 6 refs In ENGLISH; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 157)

The aim of our work was to add to the elucidation of the character of the geomagnetic field, namely in the older Palaeozoic. New results in palaeomagnetic research, as far as the investigation of the polar wandering curve is concerned, can, together with the elaboration of the dynamo theory, add to the solving of problems connected with the origin and causes of the geomagnetic field. Author

N63-18765 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
AN INSTRUMENT FOR ANALYSING THE DIRECTION OF GEOPHYSICAL ISOGRAMS [GERÄT FÜR RICHTUNGSANALYSEN GEOPHYSIKALISCHER ISOLINEN]
Bohumil Pešina (Inst. for Applied Geophysics, Brno) *In its* Collection of Geophysical Works—1961 1962 p 403–419 6 refs In GERMAN; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 158)

An instrument for analyzing the direction of geophysical isograms is described. This instrument, which consists mainly of a receiving body with a direction spoke and an integration wheel, counts and registers the angle of direction of the isogram and plots the course of direction in graphical form. I.v.L.

N63-18766 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
THE GEO-ELECTRICAL ANOMALIES OF THE RESISTANCE GENERATED BY A SPHERICAL BODY IN INFINITE HALF-SPACE [GEOELEKTRICKÉ ODPOROVÉ ANOMÁLIE VYVOLANÉ GUĽOVOU VLÓZKOU V NEKONEČNOM POLOPRIESTORE]
Silverster Krajčovič (Geophys. Lab. SAV, Brotislava) *In its* Collection of Geophysical Works—1961 1962 p 421–439 10 refs In CZECH; GERMAN and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 159)

A possible solution of the geoelectric resistance boundary value is investigated for the case of a spherical anomaly with an electrical resistance of $Q_2 \neq 0$. This anomaly exists in an infinitely homogeneous and isotropic half-space, which is characterized by a specific resistance Q_1. The method of solution involves bispherical coordinates. However, the separation of the variables by the Fourier method indicated that, by this method, it is not possible to obtain an implicit derivation of the summation constants A_n^m; B_n^m; C_n^m. The failure of this solution indicates that approximation formulas present the most reliable method for calculating the geoelectric resistances for cases involving a saturated-and-measuring electrode system. I.v.L.

N63-18767 Czechoslovak Academy of Sciences. Geophysical Inst., Prague
THE BUDKOV EARTH CURRENT OBSERVATORY [DAS ERDSTROMOBSERVATORIUM BUDKOV]
Jane Pěčová and Jaroslav Šubrt *In its* Collection of Geophysical Works—1961 1962 p 441–473 7 refs In GERMAN; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 160)

An earth-current observatory was installed at Budkov in Bohemia. This site was chosen because it offered the least distorted variations of the earth-current fields. Orientation measurements, which began in the spring of 1956, were made over a 1.3 km^2 area by conventional geolectric methods. By the end of 1957, the instrumentation in the observatory was modified to register earth currents of higher intensities. In November 1957, instrumentation was installed with a recording speed of 90 mm/hr. In February 1958, instrumentation was installed with a recording speed of 30 mm/min; and in May 1958, instrumentation with a recording speed of 22 mm/hr was installed. Recordings were made of unusual phenomena (anomalies), solar-day earth-current variations as well as short-period earth-current variations. I.v.L.

13 HEAT TRANSFER

Includes: ablation; cooling; heating; and other thermal effects.

For aerothermodynamics see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings and Control Surfaces.

For combustion see: 26 Propellants and Combustion.

For related information see: 11 Fluid Mechanics.

N63-18228 Guggenheim Labs. for the Aerospace Propulsion Sciences, Princeton U., N.J.
HEAT TRANSFER FROM A PARTIALLY IONIZED GAS TO A GASEOUS COOLANT Final Report [Feb. 1959–Sept. 30, 1962]
Peter M. Williams, Martin P. Sherman, and Paul F. Jacobs June 1963 132 p 62 refs
(Contracts Nonr-1858(31); ARPA Order 206-61)
(Aeronautical Eng. Rept. 651)

Theoretical and experimental studies were made of subsonic mixing between a partially ionized gas jet and a cool, coaxial gas flow. The gases studied were argon and helium. Both turbulent and laminar mixing regimes were investigated. In the turbulent mixing study, analytical expressions were closely verified by experiment. In laminar mixing, theoretical transport properties were computed and used to analyze the laminar mixing case. In support of both the laminar and turbulent studies, a detailed analysis of the approach to equilibrium of the jet was performed, and the radiation from the jet was studied. It was concluded that electrons were close to thermal equilibrium with other components of the jet in the zone studied. An experimental determination of the radiation loss confirmed theoretical estimates that between 5 and 10 percent of the jet energy was lost by radiation in the temperature range of interest. Author

N63-18257 ARO, Inc., Arnold Air Force Station, Tenn.
ROCKET HEAT TRANSFER MEASURING DEVICES AND TECHNIQUES
S. Wehofer Arnold Engineering Develop. Center, July 1963 61 p 19 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-93)

An investigation was conducted to find suitable devices and techniques for measuring heat-transfer rates in the base areas of rocket-powered missiles. A slug mass calorimeter was selected to measure total (convective and radiant) heat rates, and a black-body cavity was selected to measure radiant heat rates. The approach taken was to determine the source heat rate by writing a general heat-balance equation as a function of time about the heat sensing unit. An experimental program, utilizing a box-type muffle furnace to achieve a known source heat rate, was conducted to determine the accuracy of the mathematical analysis used. The results of the experimental program illustrated that heat-transfer rates may be measured with reasonable accuracy, providing basic fundamentals are adhered to and good engineering practices are utilized in the instrument design. Author

N63-18370 Georgia Inst. of Tech. Engineering Experiment Station, Atlanta
HEAT TRANSFER TO A GAS CONTAINING A CLOUD OF PARTICLES Semiannual Status Report No. 2, Dec. 1, 1962–May 31, 1963
Andrew Mc Alister, Henderson C. Ward, and Clyde Orr, Jr. June 15, 1963 35 p 8 refs
(NASA Grant NsG-273-62)
(NASA CR-50317) OTS: $3.60 ph, $1.25 mf

A theoretical and experimental analysis of radiant-heat transfer to gas-particle systems and absorptivity and emissivity of particle materials is given. An analysis of unsteady-state heat transfer between spherical particles suspended in a non-absorbing gas and subjected to a constant radiant-heat flux has been continued. Numerical calculations have been carried out for selected values of material properties and particle dimensions, partially covering the ranges to be investigated experimentally. The results, summarized in graphical form, give the particle temperatures and surrounding gas temperatures at arbitrarily selected distances from the particle surfaces as functions of the gas, the particle physical properties, and the particle concentration. An apparatus for investigating experimentally both the absorptive properties of particulate matter and the particle-gas heat-transfer interaction is being completed. It will (1) expose aerosol to a radiant field in which convective and conductive heat effects are reduced to a minimum and (2) measure calorimetrically the energy absorbed and, if possible, the particle and gas temperatures. P.V.E.

N63-18380 Bureau of Mines. Morgantown Coal Research Center, W. Va.
EXPERIMENTS WITH SOLID-IN-GAS SUSPENSIONS AS HEAT TRANSPORT MEDIUMS
William T. Abel, J. P. O'Leary, D. E. Bluman, and J. P. Mc Gee 1963 22 p 5 refs
(BM-RI-6255)

Laboratory tests were conducted with a closed, recycling system to evaluate the effectiveness of solid-in-gas suspensions as heat-transport mediums. Micronized graphite in helium or nitrogen was circulated by a centrifugal compressor to determine the feasibility of the method and heat-transfer capabilities of the mediums. Suspensions were circulated without plugging or eroding the compressor or piping. At low flow-rates and light (0.1 to 0.2 volume-percent) graphite loadings, slightly less power was required to transport a given amount of heat with suspensions than with helium alone. Graphite deposition on the heat exchange surfaces of the cooler decreased the heat-transfer effectiveness at higher solids concentration. Efforts to eliminate deposition are described.
Author

N63-18417 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
GAS IN MULTILAYER THERMAL INSULATION
Billy P. Jones June 28, 1962 19 p 10 refs
(NASA TM X-50156; MTP-RP-62-5) OTS: $1.60 ph, $0.80 mf

A review is made of the effects of gas in the multilayer thermal insulation currently considered for applications in cryogenics. Some of the results from A. G. Emslie's analysis are presented, and interpreted by comparison with data on outgassing and gas diffusion obtained from various sources. The steady-state pumping of the natural space vacuum is included for the cases of edge pumping of panels of stacked foils and for perforated stacked foils. It is found for these conditions that diffusion of hydrogen through the tank wall is not a problem at temperatures near that of liquid hydrogen. The effects on the diffusion susceptibility of the tank walls after exposure to radiation from on-board nuclear reactors are not considered. Gassing from the foils or other materials imbedded in the foils can be a serious problem. Leaks into the foils cannot be permitted. Procedures for degassing the insulation prior to launch should be investigated, and the transient space pumping problem should be studied. Author

N63-18470 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
HEAT TRANSFER TO BLUNT CONICAL BODIES HAVING CAVITIES TO PROMOTE SEPARATION
Frank J. Centolanzi Washington, NASA, July 1963 20 p 5 refs
(NASA TN D-1975) OTS: $0.50

A wind-tunnel investigation of the heat transfer to conical configurations with cavities to promote boundary-layer separation was conducted at Mach numbers ranging from 3.98 to 5.79, and Reynolds numbers of 0.12 to 0.19 million based on model diameter. Both sharp and blunt cones were tested. The results show that the presence of a cavity changes the distribution of heat transfer considerably. From the standpoint of total heat transfer there is an adverse effect of separating the boundary layer because heat transfer in the reattachment region is high and affects a considerable fraction of the total surface area. Wall cooling had a strong influence on the flow over some of the models with cavities. On some models, extreme wall cooling caused the transition point to move upstream. In one case, extreme wall cooling caused completely attached flow over a model which had a separated laminar boundary layer under adiabatic conditions. Under certain test conditions, the flow over a model with a cavity was found to pulsate. With pulsating flow, the distribution of heat transfer is similar to that observed for steady separated flow. Author

N63-18491 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
DETERMINING AERODYNAMIC HEATING RATES USING CALORIMETRIC MODELS IN THE JET PROPULSION LABORATORY HYPERSONIC WIND TUNNEL
E. A. Laumann Mar. 7, 1963 12 p 4 refs
(NASA Contract NAS7-100)
(NASA CR-50624; JPL-TM-33-121) OTS: $1.60 ph, $0.80 mf

The heat-transfer coefficients for a hemisphere-cylinder model were determined experimentally using a transient technique. The model was designed to act as a calorimeter. The results are analyzed from the standpoint of accuracy, and a comparison with the theories of Sibulkin and Lees is made. Author

N63-18643 Stanford U., Calif.
HEAT TRANSFER IN WAKES
D. B. Adarkar and W. M. Kays Apr. 1, 1963 207 p 40 refs
(Contract Nonr-225(23))
(Tech. Rept. 55)

This work concerns itself with the heat transfer from and drag on a flat plate when it is placed in the wake of an identical flat plate. Each plate is at a constant but not necessarily equal temperature. The analytical development considers the case of two collinear zero thickness plates aligned with a steady, incompressible, laminar flow, and assumes that the boundary-layer equations apply throughout. The experimental work includes heat-transfer measurements, temperature and velocity (hot wire) probing of the wake behind the first plate, vortex shedding frequency measurements, and flow visualization in a water table. Three pairs of plates of varying thickness are used. The "thin" pair is sharpened at leading and trailing edges while the thicker pairs are rectangular in cross section. The results of the experiments on the thin plates show fairly good agreement with the analysis. The discrepancies are thought to be largely due to the finite thickness of the plates as well as due to wake instability. The results of the blunt plates demonstrate the action of an interesting laminar vortex heat-transfer mechanism in the range of stable vortex shedding. Author

N63-18644 Stanford U., Calif.
HEAT TRANSFER IN A RECIPROCATING HOLLOW PISTON PARTIALLY FILLED WITH A LIQUID
J. E. Bush Apr. 15, 1963 193 p 24 refs
(Contract Nonr-225(23))
(Tech. Rept. 56)

Interest in techniques of cooling the pistons of highly supercharged reciprocating internal combustion engines has revealed the need for basic design information relating to heat transfer in a hollow reciprocating piston partially filled with a liquid. The term "cocktail shaker" heat transfer is used as a descriptive abbreviation. Analyses based on a conductive model and on a convective model for heat transfer are developed to identify the governing nondimensional parameters. Experimental data supports the conclusion that a convective mechanism of heat transfer predominates. Two correlating equations, based on experimental data, have been obtained. One equation is applicable to liquids with Prandtl number >0.5, and the other is applicable to liquids with Prandtl number $\ll 1$. These correlating equations can be used in the design of internal combustion engine pistons and valves which are cooled by cocktail shaking. Author

N63-18739 National Aeronautics and Space Administration. Washington, D.C.
REENTRY EXPERIMENT WILL TEST ABLATION MATERIAL
News Release No. 63-153
July 17, 1963 9 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

A flight experiment to find out how well a spacecraft heat shield material, known as a charring ablator, performs during actual reentry into the atmosphere at 18,600 miles per hour will be launched from Wallops Island by NASA. This experiment will be the first flight test of an ablation material at superorbital reentry speeds in a high-energy environment not fully attainable by ground simulation. The heat shield experiment will be flown on a Scout vehicle. The trajectory of the experiment will expose the heat shield material to some of the altitude and speed conditions expected to occur during reentry from a lunar mission. Reentry will occur nearly 1000 miles down range from Wallops Island. The instrumentated payload and the burned-out fifth-stage rocket motor, which has been added to the Scout vehicle to attain the required velocities, will drop into the Atlantic several hundred miles northeast of Antigua about 12 minutes

after launch. The flight will take place during maximum darkness and a meteor-like trail will be visible during the reentry phase. Top speed is expected to occur at 70 miles altitude. Radar, telemetry, and optical means will be used to gather scientific information. I.v.L.

N63-18742 ARO, Inc., Arnold Air Force Station, Tenn.
A STUDY OF LAMINAR HEAT TRANSFER TO SPHERICALLY BLUNTED CONES AND HEMISPHERE-CYLINDERS AT HYPERSONIC CONDITIONS
B. J. Griffith and Clark H. Lewis Arnold Eng. Develop. Center, June 1963 36 p 25 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-102)

Heat-transfer distribution data obtained in the arc-driven tunnels (hotshot type) of the von Kármán Gas Dynamics Facility, AEDC, are presented. Data were taken on a 9-deg half-angle spherically blunted cone and a hemisphere-cylinder, at Mach numbers between 17 and 20, and Reynolds numbers per foot in the free-stream between 100,000 and 800,000. The test data are compared with theory and available shock-tube and shock-tunnel results. Good agreement between Lees' theory and measured heat-transfer rates demonstrates the capability of the VKF hotshot tunnels to obtain heat-transfer distribution data. The data indicate a strong dependence of the heat-transfer distribution on pressure distribution, Mach number, and cone half-angle. The heat-transfer data are correlated over a wide range of Mach numbers and cone angles. Correlation curves and formulas are presented for the pressure and heat-transfer distribution to spherically blunted cones at hypersonic conditions. Author

N63-18751 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
SELECTION OF SURFACE THERMOMETERS FOR MEASURING HEAT FLUX
John W. Kurzrock Feb. 1963 47 p 20 refs
(Contract AF 40(600)-804)
(CAL-124)

Classical solid conduction theory is applied to a composite semi-infinite slab for the constant surface heat flux case to determine the operating limits of surface thermometers. It is shown that two dimensionless parameters σ and θ_F specify the operating range of surface thermometers. A surface thermometer is selected on the basis of these dimensionless parameters, the heat flux range, the testing time, and the output sensitivity. Experimental results of thin- and thick-film surface thermometers are compared with solid conduction theory to indicate the effect of thermal contact resistance between the film and the mounting material, and to verify the theoretical film thickness. The results indicate that thick-film thermometers (calorimeters) can measure heat flux one to two orders of magnitude higher than thin-film thermometers for the same time interval. The thin-film thermometers are useful for measuring lower heat flux where high sensitivity is required. A comparison of experimental heat-flux results using thin- and thick-film thermometers indicated that the thin-film data was 15% to 40% below the thick-film data. This difference was postulated to be the use of thin-film thermometers with thicknesses of 1μ, instead of the required thickness of .1μ or less. Author

14 HUMAN BEHAVIOR

Includes: crew training and evaluation; piloting; psychological factors.

For simulators see: 10 Facilities.

For related information see: 16 Life Sciences.

N63-18246 Bell Aerosystems Co., Buffalo, N.Y.
DEVELOPMENT AND TEST OF THE BELL ZERO-G BELT [Final Report, July-Dec. 1962]
Ralph E. Flexman, Leonard M. Seale, and Campbell Henderson Wright-Patterson AFB, Ohio, Behavioral Sciences Lab., Mar. 1963 109 p 18 refs
(Contract AF 33(657)-9224)
(D7123-953002; AMRL-TDR-63-23) OTS: $2.50

This report discusses the general problem areas and specifically reports on the research, development, and testing of the Bell Zero-G Belt, a research propulsion and control system for maneuvering a man in a weightless environment. The flight tests of the belt took place on a large airbearing platform and in a C-131 cargo-type aircraft during zero-g trajectories. The equations-of-motion derived during the Bell Aerosystems Company sponsored development of the Small Rocket Lift Device (Rocket Belt) are also presented and discussed with respect to the Zero-G Belt. Specific conclusions are presented on the adequacy of the research model of a propulsion system, and recommendations are made for additional research and development. Author

N63-18264 Ohio State U. Lab. of Aviation Psychology, Columbus
THE RETENTION OF DISCRETE AND CONTINUOUS TASKS AS A FUNCTION OF INTERIM PRACTICE WITH MODIFIED TASK REQUIREMENTS [Final Report, May 1960-Aug. 1962]
Donald R. Brown, George E. Briggs, and James C. Naylor Wright-Patterson AFB, Ohio, Behavioral Sciences Lab. May 1963 25 p 8 refs
(Contract AF 33(616)-7269)
(AMRL-TDR-63-35) OTS: $1.75

Laboratory research is reported on retention of continuous (tracking) and of discrete (procedural) tasks as a function of rehearsal conditions (simplified versus "operational" rehearsal tasks). All rehearsal conditions led to superior retention of the tracking task compared to a no-rehearsal condition, and certain of the procedural task scores indicated the same result. However, little evidence was found to indicate reliable differences among the several rehearsal conditio. It was concluded that sufficient original training will eliminate any potential differences among rehearsal conditions. Author

N63-18268 Applied Psychology Corp., Arlington, Va.
DISTANCE ESTIMATION OF FREQUENCY-CODED AND UNIFORMLY FLASHING LIGHTS Technical Report No. 12
June 1962 24 p refs
(Contract FAA/BRD-127)

The accuracy with which pilots can judge the distance to a uniformly flashing light and to a light providing flash-rate cues of distance was measured in a laboratory setting, for the purpose of determining whether distance cues improved accuracy. For each kind of light, subjects made practice judgments in which they were told their accuracy, then they completed a series of test problems without accuracy information. Results indicate that judgments made without flash-rate cues are as accurate as when these cues are provided. Nearer lights tend to be judged as being farther away than they actually are, and far lights are judged as being nearer. Author

N63-18286 Bolt, Beranek, and Newman, Cambridge, Mass.
ADAPTIVE CHARACTERISTICS OF MANUAL TRACKING
Laurence R. Young, David M. Green, Jerome I. Elkind, and Jennifer A. Kelly [1963] 22 p 4 refs Presented at the 4th Natl. Symp. on Human Factors in Electronics, Men, Machines and Systems, Washington, D.C., May 2–3, 1963
(NASA Contract NASw-185)
(NASA CR-50297) OTS: $2.60 ph, $0.86 mf

The ensemble average technique, applied to the error signal following changes in control-system characteristics, appears to give a relatively clear picture of the process of adaptation. It also identifies the approximate times required for the human operator to adapt to a control change and to complete his adjustment to this change. The average error curves of Part III indicate that for the very simple situation under investigation, the adaptation times are on the order of 0.5 to 1.0 sec. Once having adapted, or taken on the correct strategy to go with the new control-system mode, the subject requires only an additional 0.3 sec or so to complete his adjustment to the new control mode. This is merely one basic movement time or sampling period if one considers a sampled-data model for the human operator. It must be emphasized that the results shown in Part III are preliminary results only, taken on one subject with a simple position control in the compensatory mode. The ensemble average technique does, however, appear to be a useful tool for investigating the adaptation process, which otherwise defies both sophisticated and simple-minded analysis techniques. Author

N63-18402 Arizona U., Tucson
INFORMATION PROCESSING CAPACITY IN SINGLE AND DUAL SENSORY CHANNELS
Ridgely W. Chambers May 1963 103 p 26 refs
(NASA Grant NsG-191-62)
(NASA CR-50067) OTS: $9.10 ph, $3.29 mf

Two hypotheses have been postulated to explain why man's ability to respond to a continuous stream of information suffers a time decrement if the information occurs at a rate of more than one event per half second. These hypotheses are the psychological refractory period hypothesis and the expectancy hypothesis. The psychological refractory period hypothesis leads to the conclusion that humans are single-channel information-processing systems, whereas the expectancy hypothesis suggests that, given the appropriate expectancies, humans can be multichannel systems. This study attempts to formulate an information hypothesis showing how the human organism can appear to be a multichannel system while in reality he is a single-channel system. Furthermore, the study attempts to determine if the Shannon–Wiener formulation of the definition of information is adequate for the context of human information processing. The technique of requiring the simultaneous presentation of continuous streams of information through two transducer systems in the organism was used both within and between sense modalities. The modalities investigated were the visual sense and the auditory sense. Results indicated that: (1) the rate of information processing was dependent on the rate of information transmitted; (2) information values based on the Shannon–Wiener formulation, which is in turn based on relative frequency measures of events, were not adequate if the events were entirely experimenter defined. I.v.L

N63-18453 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
TRAINING OF COSMONAUTS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 236–241 (See N63-18430 17-32)

Prospective astronauts were selected after interviews were held with a great number of aircraft pilots. The best ones underwent thorough clinical and psychological examinations. As a result of the clinical–physiological examination, a group was formed which underwent a program of special training, training on special stands and trainers, and imitating underground and flight conditions—the factors of cosmic flight. The special training and testing program included flights on aircraft under weightlessness conditions; training in a model cabin of a cosmic ship and on a special trainer; longer stays in a specially equipped soundproof chamber; training on a centrifuge; and parachute jumps from aircraft. After the special training program direct training for the forthcoming cosmic flight began. This training included (1) studying of flight missions, maps of landing region, piloting instructions, radio communications; (2) studying emergency supply and utilization, and direction-finding systems; centrifuge testing in protective clothing at maximum values of anticipated overload; and (3) long-lasting testing in a make-believe cosmic ship. As a result of the scientific-training operations, a group of cosmonauts were selected that were ready for flight into cosmic space. N.E.A.

N63-18454 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
FIRST COSMIC FLIGHT
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 242–249 (See N63-18430 17-32)

The cosmic ship VOSTOK blasted off on April 12, 1961, at 9 hrs. 7 min., Moscow time. During the entire time of orbiting, pilot Yu. A. Gagarin maintained continuous radiotelephone communication with the ground vectoring center. Data were transmitted on the changes in overloads at the moments the stages separated themselves from the carrier rocket. Operation of the board equipment during flight in orbit, orientation, and descent of the ship were controlled automatically. The pressure in the cabin of the ship during flight was maintained at 750 to 770 mm Hg, air temperature at 19° to 22° C, relative humidity 62% to 71%. The surface of the earth was surveyed from an altitude of up to 300 km. From the first human flight into cosmic space, Yu. A. Gagarin has shown that a person can normally endure conditions of cosmic flight, and conditions of orbiting and return to the surface of the earth. This flight has proved that under conditions of weightlessness a person can fully retain freedom of operation, motion coordination, and clearness of thought. The flight furnished valuable data on the performance of the construction and equipment of the cosmic ship in flight. Approval was given to the reliability of the carrier-rocket and structural perfection of the satellite–satellite ship. N.E.A.

N63-18632 Air Force Cambridge Research Center, Bedford, Mass.
TESTING FOR EXTRASENSORY PERCEPTION WITH A MACHINE
William R. Smith, Everett F. Dagle, Margaret D. Hill, and John Mott-Smith May 1963 34 p 46 refs
(AFCRL-63-141)

A design of a scientifically rigorous experiment in extrasensory perception (ESP) is presented as an acceptable model for work in this field. This report covers the design of an objective test of three modes of ESP, pretest considerations and planning, final testing, and results obtained using the specially designed testing and recording machine, the VERITAC. A statistical analysis of the results and a discussion of statistical considerations are presented. Author

N63-18665 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ROUGH-AIR EFFECT ON CREW PERFORMANCE DURING A SIMULATED LOW-ALTITUDE HIGH-SPEED SURVEILLANCE MISSION
George J. Hurt, Jr., Washington, NASA, Aug. 1963 23 p 4 refs
(NASA TN D-1924) OTS: $0.75

The NASA normal acceleration and pitch simulator, in conjunction with an analog computer, was used to simulate a vehicle flying through rough air at high subsonic Mach numbers. Vehicle response levels which were in excess of the accepted

human comfort level were imposed on the test subjects. At the maximum levels investigated, it was found that the observer would be disrupted but not stopped in the performance of the assigned tasks. Author

N63-18725 Iowa Inst. of Hydraulic Research, Iowa City
VARIATION OF VISCOUS DRAG WITH FROUDE NUMBER
Jin Wu and L. Landweber June 1963 8 p 6 refs

Wavemaking resistance, taking into account the effect of free surface and the concomitant surface waves generated by the hull on viscous drag, is investigated. Results obtained from this investigation are compared with results obtained by the 1957 ITTC correlation formula which did not take into account this effect. All wave survey measurements were taken in a transverse plane at a distance of 1/2-model length behind a series 60 ship model, at seven different speeds corresponding to the speed-length ratios $V/\sqrt{L} + 0.05$, 0.6, ... 1.1, where V is in knots and L is the model length in feet. At each speed, 374 total-head readings and 352 pressure-head readings were taken at horizontal and vertical intervals of 0.1 foot. Runs were made at time intervals of 8 minutes. The water temperatures, measured every half day, before and after testing, at the water surface and at a depth of 2 feet, were the same at both depths. In the course of the tests, the temperature varied between 59.7° and 60.5° F. The water surface in the plane of measurements across the wake was found to vary slightly from the level of the undisturbed surface. This variation was measured and its mean level was used in evaluating the viscous drag integral. The coefficients of the measured viscous drag and total resistance and the drag coefficient value, obtained from the 1957 ITTC correlation formula, were graphed against speed-length ratio. The measured viscous drag coefficient deviated considerably from the correlation line, varying about 10% below and about 5% above the line. Also, values of the residuary-resistance coefficients and the wave-making resistance were graphed against the Froude number $V/\sqrt{Lg}$. The values for the wave-making resistance were greater than the values of the residuary resistance for Froude numbers less than 0.26 and were slightly less than the residuary resistance at larger Froude numbers. I.v.L.

15 INSTRUMENTATION

Includes: design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; and sensors and transducers.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

N63-18214 Therm, Inc., Ithaca, N.Y.
A FLUXGATE MAGNETOMETER FOR SPACE APPLICATION
S. C. Ling N.Y., AIAA [1963] 15 p 10 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Contract NASr-46)
(AIAA Paper 63-187) AIAA: $0.50 members, $1.00 nonmembers

A new type of fluxgate magnetometer is presented. The gating principle is based on the combination of several physical properties required to achieve a near ideal decoupling between the gating flux field and the ambient field. A simplified phenomenological theory is presented to explain the general mechanics of an orthogonal fluxgate, and in addition, the general characteristic of the spectrum of transverse induction is discussed. Experimental values for a typical magnetometer, as well as its simple electronic circuit, are presented to demonstrate its working principle. The main emphasis of this paper is to present the basic principle and characteristic of this new fluxgate magnetometer; therefore, no attempt is made to discuss magnetometers which involve more complex electronic circuitry. Author

N63-18215 Sylvania Electric Products, Inc. Electronic Systems Div., Needham, Mass.
FINE GUIDANCE SENSOR FOR HIGH PRECISION CONTROL OF THE OAO
Norman A. Gundersen N.Y., AIAA [1963] 12 p Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(NASA Contract NAS5-1810)
(AIAA Paper 63-211) AIAA: $0.50, members, $1.00 nonmembers

The optical and physical layout of the fine guidance sensor to be used on the Orbiting Astronomical Observatory for examining the extremely fine absorption lines that are expected to be observed when examining the radiation from selected stars, are described. The fine absorption lines are caused by the interstellar gas clouds which exist at extremely low pressure and lie in the line of sight to the star. P.V.E.

N63-18223 Nagoya U. Research Inst. of Atmospherics (Japan)
A HIGH-RESOLUTION INTERFEROMETER FOR POLARIZATION MEASUREMENTS AT 9.4 Gc/s.
Takakiyo Kakinuma and Haruo Tanaka *In its* Proc. of the Res. Inst. of Atmospherics, Nagoya U., Vol. 10 Jan. 1963 p 25–33 13 refs (See N63-18220 17-21)

A compound interferometer with 0.7 min. arc for polarization measurements at 9.4 gc/s was completed at Toyokawa. It consists of the preexisting 16-element interferometer and a new 2-element interferometer, the total length being about 90 meters. A new type of phase switch using a ferrite switch and a turnstile junction is practically free from amplitude modulation. A completely linear phase shifter, consisting of a single turnstile junction, is used for phase adjustment. S/N ratios of various multiplying systems are discussed. Author

N63-18270 General Geophysical Co., Houston, Tex.
STUDY OF SEISMIC SIGNALS AND NOISE DETECTED BY A BURIED ARRAY Final Report, Jan. 15, 1962–Mar. 15, 1963
G. C. Phillips, Changsheng Wu, and J. C. Woodall Apr. 1963 117 p 7 refs
(Contract AF 19(628)-341; ARPA Order 180-61, Amend. 2; Proj. Vela-Uniform)
(AFCRL-63-479)

Simultaneous recordings of seismic signals and noises with instruments consisting of a short period, vertical-movement Benioff seismograph and an array of seven shallowly buried, low-frequency seismometers have been compared. In general, the same earthquake signals were recorded in both systems, but the amplitudes of undesired background noise have been reduced in the buried-array system. It is concluded that the buried-array system produces a cleaner, more outstanding, P-wave arrival event. Equipment and field procedure features of the buried-array system are described. Author

N63-18290 Columbia U. Lamont Geological Observatory, Palisades, N.Y.
DESIGN AND CONSTRUCTION OF A LUNAR SEISMOGRAPH Progress Report, Jan. 1–Mar. 31, 1963
M. Ewing 1963 34 p
(NASA Contract NASw-82)
(NASA CR-50245; Rept. 15) OTS: $3.60 ph, $1.22 mf

Preparation of design requirements for the short-period vertical seismometer to be employed as a backup instrument for early Surveyor flights is reported. A slightly modified version of the Surveyor seismograph system has been built (using other support) for use on the ocean floor. The Surveyor breadboard system is being prepared for longterm operation in a mine where a highly stable environment exists for measurement of earth tides. Author

N63-18293 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
HIGH RESOLUTION WIND AND WIND SHEAR MEASUREMENT WITH DOPPLER RADAR Final Report, 5 Apr. 1961-5 June 1962
James E. Jiusto 1962 99 p 14 refs
(NASA Contract NAS8-1520)
(NASA CR-50169; CAL-IH-1525-P-1) OTS: $8.60 ph, $3.17 mf

A wind-measurement concept was formulated in which two Doppler radars are used to sense the motion of chaff introduced into the atmosphere. Research was performed on the meteorological interpretation of Doppler frequency spectra so obtained, and on suitable techniques of measurement of chaff clouds or meteorological targets (clouds, rain, snow). While the radar-chaff concept does not feature the simplicity and economy of more standard wind-measurement techniques, it does offer the combined advantages of fine spatial resolution, accuracy, "real time" presentation, wind-variability detection, and all-weather performance. Exploratory field experiments conducted with a single radar of modest performance characteristics established the feasibility of Doppler radar as a device for high-resolution wind measurements. The tests served further to help define desired operating features of the ultimate system. Comparative measurements of mean wind velocity were obtained with the Doppler radar, by smoke trail photography, and by standard radiosonde methods. Author

N63-18303 Illinois U. Coordinated Science Lab., Urbana
MINIMIZING PRECESSION TORQUES IN THE ELECTRICALLY SUPPORTED GYRO
Don R. Allen May 1963 162 p 15 refs
(Contract DA-36-039-SC-85122)
(R-165)

The problem of minimizing precession torques in a nongimballed mode of gyro operation is treated. With any number of electrodes, these torques are minimized by arranging the electrodes in opposing pairs, and by maintaining a particular electric-field distribution over the entire sphere. These torques are also decreased by keeping the interelectrode spacings between electrodes to a minimum, and to some extent, by increasing the electrode number. A support servosystem was developed to experimentally measure precession torques on a purposely distorted rotor placed in both a six-round-electrode housing—the electrodes placed in the pattern of a cube—and a twenty-triangular-electrode housing—the electrodes placed in the pattern of an icosahedron. The electric field torques were determined by noting the equilibrium position of the "spin axis" of the purposely distorted nonspinning rotor as a function of the orientation of that axis with respect to the movable electrode housing. The electric torques were counterbalanced by the known mass-unbalance torque. A theoretical reduction in electric torques of about fifteen in the twenty-electrode housing over the six-electrode housing is possible, and the experiments show a reduction of about five. Author

N63-18354 Harvard Coll. Observatory, Cambridge, Mass.
THE HARVARD SOLAR SATELLITE PROJECT
W. Liller Repr. from J. Quant. Spectrosc. Radiat. Transfer, v. 2, [1962] p 519-526 7 refs
(Its Repr. 608)

The Harvard College Observatory is preparing instrumentation for an Orbiting Solar Observatory which is scheduled to be launched in 1963. Planned is a scanning spectrometer which will operate in the wavelength range from λ500 Å to λ1500 Å. The entrance slit will be at the focus of a 0.5-in.-diameter off-axis paraboloidal mirror, and the resulting angular field of view will be approximately 1 $min.^2$ of arc. Normally, the stabilized satellite will point the instrument to within a few min. of arc of the sun's center, where detailed scans of the solar spectrum will be made. However, a command system will allow an operator on the earth to stop the spectral scan at any desired wavelength. In response to a second command, the satellite will begin a stepped raster scan of the sun's image, thereby generating a monochromatic picture of the solar surface. The final image will be 40 min. × 40 min. of arc and will consist of 1600 picture elements; the intensity of each element will be known to 1-percent accuracy. Author

N63-18369 Solid State Radiations, Inc., Los Angeles, Calif.
DEVELOPMENT OF MEDICAL AND BIOLOGICAL SEMICONDUCTOR DETECTORS Third Quarterly Report
J. Friederichs, J. Moross, J. Berdaner, et al Apr. 30, 1963 28 p
(NASA Contract NASw-415)
(NASA CR-50521) OTS: $2.60 ph, $1.04 mf

The major effort was placed on the fabrication and evaluation of 3-mm-diameter medical probes suitable for *in vivo* measurements. Specifically, the fabrication process for these detectors was finalized, and a number of these detectors were fabricated. After the mechanical and electrical characteristics of the devices were obtained, the units were evaluated in various nuclear environments. This report contains a summary of the final fabrication procedure used, as well as the results of the evaluation of these detectors. The detectors were evaluated with alpha particles, betas, and Co^{60} gammas. In particular, the data obtained with P^{32} solutions demonstrated that *in vivo* measurements at typical medical-dosage levels could be carried out easily. Author

N63-18445 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
MEASUREMENT OF MAGNETIC FIELD NEAR EARTH AND MOON
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 146-151 (See N63-18430 17-32)

A summary of geomagnetic measurements inside and outside the ionosphere of the earth from magnetometer data of the first, second, and third Soviet satellites is presented. These data furnish proof for the presence of ionospheric sources which cause variation associated with the earth-field disturbances. Analysis of the obtained data indicates the presence of short, fast changes in the earth field, coinciding in time with the passage of the third Soviet satellite through the F layer of the ionosphere. The first Soviet cosmic rocket showed that the magnetic earth field, at distances of 3 to 4 terrestrial radii, is determined not only by calculated values from the magnetic earth potential, but depends also on external sources. Magnetic measurements from the second cosmic rocket suggest that there is no magnetic field at the moon; therefore, any effort to explain certain geophysical phenomena by the effect of the lunar magnetic field should now be considered as absolutely baseless. N.E.A.

N63-18446 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
INVESTIGATION OF MICROMETEORS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 152-154 (See N63-18430 17-32)

An apparatus consisting of ballistic Piezo-feelers (from ammonium phosphate) and an amplifier-converter was installed on the third manmade earth satellite and on cosmic rockets to investigate meteoric particles. The apparatus registered the number of particle impacts and energy, as well as energy measured by the pulse magnitude of the material of the sensing device, ejected during the explosion of meteorite particle on its surface. Measurement results indicated that: (1) density of meteoric matter in the periphery of the earth is not constant; it changes in space; and (2) maximum number of recorded impacts belong to particles with masses ranging from $(3 + 8)10^{-9}$ to $(2 + 3)10^{-8}$g and smaller. These results show that meteoric and micrometeoric danger is small. N.E.A.

N63-18480 Denver U., Colo.
THE UNIVERSITY OF DENVER HIGH-ALTITUDE INFRARED BACKGROUND INVESTIGATION
David G. Murcray *In* Chicago U. Labs. for Applied Sciences, III. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 86–94 (See N63-18473 17-10)

A brief description is given of the balloon-borne radiometer system that has been constructed to make measurements of the infrared background of the earth. For the initial measurements, the radiometer was equipped with a thermistor bolometer detector and filters with various spectral band passes in the region from 1μ to 30μ. Recently the radiometer system has been modified, and the thermistor bolometer replaced by a cooled InSb detector. The filters have been replaced with filters of various spectral bandwidth centered around 2.7μ and 4.3μ atmospheric absorption bands. The modified radiometer system has been flown a number of times this spring, and some preliminary results obtained on these flights are presented. These indicate that high spectral radiances can be observed in the 2.7μ region even on "clear" days. These high radiances appear to be the result of forward scattering of the solar radiation. Author

N63-18481 California U., San Diego. Visibility Lab.
MEASUREMENT PROGRAMS IN THE VISIBLE
A. R. Boileau *In* Chicago U. Labs. for Applied Sciences, III. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 96–102 (See N63-18473 17-10)

The instrumentation of an Air Force B-29 which had been assigned to the Visibility Laboratory for visibility studies is described. The flight pattern and data obtained are discussed, followed by a description of the instrumentation to be installed on a replacement aircraft, an Air Force C-130. Author

N63-18497 Michigan U. High Altitude Engineering Lab., Ann Arbor
NEUTRAL COMPOSITION OBTAINED FROM A ROCKET-BORNE MASS SPECTROMETER
Edward J. Schaefer and Myron H. Nichols [1963] 22 p 4 refs Repr. from ARS Journal, v. 31, no. 12, Dec. 1961 p 1773–1776 Presented at COSPAR 4th Intern. Space Science Symp., Warsaw, June 3–11, 1963
(NASA Contract NASw-138)
(NASA CR-50465)

A quadrupole mass spectrometer has been designed for studies of neutral atmospheric composition between 100 and 200 km, using Nike-Cajun and Nike-Apache rockets. A successful technique of ejecting the payload at altitude from an evacuated volume to reduce contaminants has been developed. The ion source has been designed for direct immersion in the ambient atmosphere with the greatest open-look angle possible. The number of surface collisions experienced by a particle prior to ionization has thereby been reduced to the order of one or two, and the probability of surface recombination of atomic oxygen has been correspondingly reduced to the order of one percent. The first successful daytime flight of a continuing program yielded an O_1/O_2 current ratio which was unity at 118 km, and 3.1 at 134 km. Preliminary data analysis of the first successful nighttime flight yielded O_1/O_2 current ratios in substantial agreement with the daytime flight, and extended the data to 190 km where the ratio was 9.5. These values are about an order of magnitude greater than those obtained heretofore by other investigators, and achieve much closer agreement with ultraviolet measurements and theoretical predictions. On the basis of the daytime data, a mean molecular weight of approximately 24.6 is derived at 134.5 km. Author

N63-18638 Aeronautical Research Labs., Wright-Patterson AFB, Ohio
A VERSATILE APPARATUS FOR THE STUDY OF REFRACTORY INDEX FIELDS IN CASES Technical Report
F. J. Weinberg (Imperial Coll. of Science and Tech.) Feb. 1963 41 p 22 refs
(Contract AF 33(616)-7022)
(ARL-63-45) OTS: $1.25

A relatively inexpensive optical system is described which is capable of interferometry, deflection mapping, shadowgraphy, and the entire range of schlieren recording. It is easy to set up, requires only minor adjustments to convert it from one function to another and, when desired, can fulfill several of them simultaneously. Its construction is discussed and illustrated by a variety of records. Author

N63-18654 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ULTRAVIOLET PHOTODETECTORS
Lawrence Dunkelman Washington, NASA, Aug. 1963 19 p 50 refs Presented at the 1st Internatl. Conf. on Vacuum Ultraviolet Radiation Phys., U. of Southern Calif., Apr. 16–19, 1962 Previously processed as a reprint, See N63-13578 08-15
(NASA TN-D-1718) OTS: $0.50

This report reviews the characteristics of vacuum ultraviolet ion chambers having fill gases such as nitric oxide, acetone, carbon disulfide, or ethylene oxide with windows of lithium fluoride, cadmium fluoride, or barium fluoride. Their quantum efficiencies range from approximately 0.10 to 0.50 photoelectron/quantum, and the chambers may be operated in a gas multiplication mode with gains of 10^3 at 600 to 800 volts. The characteristics of photomultipliers and phototubes having alkali-tellurium, copper-iodine, or other cathodes with lithium fluoride, sapphire, quartz, or no windows are described. Some of the photomultipliers studied have quantum efficiencies as high as 0.20 photoelectron/quantum, and exhibit long-wavelength rejection ratios of many orders of magnitude over only several hundred angstroms. Author

N63-18669 National Aeronautics and Space Administration. Washington, D.C.
MEASUREMENT OF TORSIONAL RIGIDITY OF STIFFENED PLATES
Herbert Becker and George Gerard (New York U.) July 1963 39 p 12 refs
(NASA Grant NsG-17-59)
(NASA TN D-2007) OTS: $1.00

An instrument developed for measuring torsional rigidity of stiffened structures is described. Use of the instrument is discussed, and calibration procedures are explained. Perspective on the investigation is provided by the inclusion of pertinent theories for torsional rigidity with which the experimental measurements are compared. Author

N63-18680 Bell Helicopter Co., Fort Worth, Tex.
ALTIMETER DISPLAY AND HARDWARE DEVELOPMENT, 1903 – 1960 [Interim Report]
David A. Schum, John R. Robertson, and W. Guy Matheny Wright-Patterson AFB, Ohio, Flight Control Lab., May 1963 171 p 79 refs
(Contract AF 33(616)-7248)
(ASD-TDR-63-288) OTS: $1.00

The literature on altimeter display and hardware development is reviewed. Major emphasis is upon human engineering aspects of altimeter display development and upon the methods and modes of altimeter mechanization and sensing. A two-fold method of display categorization is offered. The evolution of altimeter displays is explored in an historical survey of display development. The various altimeter designs are also described in terms of certain display categories. Author

N63-18733 Hanford Atomic Products Operation, Richland, Wash.
HIGH LEVEL DOSEMETER WITH METER INDICATION AND AURAL SIGNALING
C. A. Ratcliffe and E. M. Sheen July 3, 1963 11 p
(Contract AT(45-1)-1350)
(HW-77517) OTS: $0.50

A prototype dosemeter was developed and satisfactorily tested. It has a presettable trip dose from 10 to 100 r, an aural indicator that signals the accumulation of the preset dose, and a meter that indicates the dose accumulation. The dosemeter employs a 10-cc ion chamber as a detector, and is both lightweight and pocket-sized. Operational periods of 30 minutes can be achieved before adjustment becomes necessary. Author

16 LIFE SCIENCES

Includes: biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems; and space sickness.

For related information see: 14 Human Behavior; and 28 Space Radiation.

N63-18217 Aerospace Information Div., Library of Congress, Washington, D.C.
RADIATION EFFECTS ON BIOLOGICAL MATERIALS
I. V. Vysochina et al June 24, 1963 11 p AID Press Review of 10 articles from Radiobiologiya (Moscow), v. 3, no. 2, 1963 (AID-996) OTS: $1.60 ph, $0.80 mf

Synopses of original books and articles in Russian are presented on the effect of radiation on biological material. Reported are: (1) respiration function of blood in rabbits exposed to lethal doses of X-irradiation; (2) restoration of hematopoiesis in dogs that had survived acute radiation sickness; (3) effect of sensitization on the reactivity of an irradiated organism; (4) methods for evaluating radioprotective activity of chemical compounds; (5) prevention of radiation-induced depolymerization of DNA of rat liver by means of propylgallate and 5-methoxytryptamine; (6) prophylactic effect of 5-methoxytyrptamine on radiation sickness in monkeys; (7) radioprotection of thymocytes in rats with indole derivatives; (8) radioprotection of hematopoietic organs in mice; (9) radioprotective action of polyanions of X-irradiated mice; and (10) quantitative dependence of protective activity of "antifeins" on the irradiation dose. N.E.A.

N63-18237 Cincinnati U. Coll. of Medicine, Ohio
MEDICAL ASPECTS OF RADIATION ACCIDENTS. A HANDBOOK FOR PHYSICIANS, HEALTH PHYSICISTS AND INDUSTRIAL HYGIENISTS
Eugene L. Saenger, ed. Washington, AEC [1963] 367 p refs
(Contract AT(30-1)-2106)
GPO: $1.75

The diagnosis and treatment of radiation injury is examined. The handbook covers (1) rules for physicians, (2) procedures to be followed during the first 12 hours, (3) later emergency period and clinical features of the acute radiation syndrome, (4) therapy and long-term follow-up studies, (5) hospital disaster plans for radiation accidents, (6) problems of psychological upset, (7) accidents involving external sources of radiation, exposure to radionuclides, reactors, and critical assemblies, and nuclear chain reacting systems, (8) role of civilian and governmental authorities and legal requirements, (9) fires from nuclear materials and nonmilitary weapon accidents, and (10) purification of food and water. Included is an appendix covering measurement of radiation, radiation emission, radiobiology, rules for working with radionuclides, and radionuclides encountered in accidents. J.L.D.

N63-18239 Eidgenössische Technische Hochschule, Zurich (Switzerland)
BIOLOGICAL EFFECTS OF NOISE
Etienne Grandjean *In* International Commission on Acoustics Congress Report II [of] the Fourth Intern. Cong. on Acoustics, Copenhagen, Aug. 21–28, 1962 p 109–114 (See N63-18238 17-23)

Annoyance due to noise, disturbing rest, is an important health hazard from the biological point of view. It is therefore reasonable to consider annoyance as a biological standard for noise abatement. Noise is increasing gradually in civilized countries. Simultaneously, the frequency of complaints about noise is increasing. It must be concluded that excessive noise exceeds more and more the limits of adaptation, or habituation. Noise is added to other stresses of modern life, like haste and restlessness, increasing tobacco consumption, sedentary life with inadequate nutrition, and, in some places, increasing air pollution. Noise is therefore one of the important problems of modern hygiene, and its abatement is a well-justified postulate. Author

N63-18310 Texas U. Electrical Engineering Research Lab., Austin
CONSIDERING FOREST VEGETATION AS AN IMPERFECT DIELECTRIC SLAB
D. J. Pounds and A. H. La Grone May 31, 1963 73 p 31 refs
(Contract AF 19(604)-8038)
(Rept. 6-53; AFCRL-63-483)

A method for representing a grove of trees by an imperfect dielectric slab is developed and illustrated. The method considers leaves as conducting bodies and bark and wood as dielectric bodies, using artificial dielectric and dielectric mixture theory to compute the real part of the dielectric constant of the proposed slab. The imaginary part of the dielectric constant of the slab is computed from measured attenuation data. The method is illustrated, using data from a real forest to compute the characteristics of an imperfect dielectric slab. Author

N63-18339 Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio
SOME CARDIORESPIRATORY RESPONSES OF FLYING AND NON-FLYING PERSONNEL TO DIFFERENT VECTORS OF ACCELERATION WITH CORRELATION OF THESE RESPONSES TO OTHER VARIABLES [Final Report]

Alvin S. Hyde, Neil S. Cherniack, Evan F. Lindberg, and Dorothy Whately Dec. 1962 13 p 9 refs
(AMRL-TDR-62-151) OTS: $0.50

The cardiovascular and respiratory responses of test pilots are compared with the AMRL centrifuge panel members during headward (+ G_z) and forward (+ G_x) accelerations. Vital capacity decreased in all subjects with increasing forward acceleration. No significant difference existed between the cardiorespiratory performance of test pilots and that of the nonrated personnel that constitute the AMRL centrifuge panel. No correlation was noted between blackout and pulse rate, but correlation did exist between resting control and + 5 G_z pulse rates. An extensive number of anthropometric measurements, indices of physical fitness, and measurements made during other stress did not correlate with tolerance to headward (+ G_z) acceleration or with respiratory performance during + G_z and + G_x acceleration. Author

N63-18345 Argonne Cancer Research Hospital, Chicago, Ill.
SEMIANNUAL REPORT TO THE ATOMIC ENERGY COMMISSION
Leon O. Jacobson and Margot Doyle, eds. Mar. 1963 126 p 250 refs
(Contract AT(11-1)-69)
(ACRH-19) OTS: $2.50

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4. PROTECTIVE EFFECT OF AET ON THE IMMUNE MECHANISM OF X-IRRADIATED MICE E. L. Simmons and O. Lartigue p 39–42 7 refs

5. CYSTEAMINE PROTECTION OF X-RAY INDUCED DYSPLASIA IN MOUSE HAIR F. D. Malkinson, M. L. Griem, D. M. Phillips, and P. H. Morse p 43–48 23 refs

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8. RELATION BETWEEN THE ABSORBANCY AND THE QUENCHING OF LIQUID SCINTILLATION SAMPLES J. De Bersaques p 57–59 8 refs

9. THE NON-ANTIGENICITY OF SYNTHETIC POLYRIBONUCLEOTIDES AND APURINIC ACID S. Yachnin p 60–61 10 refs

10. THE ENZYMATIC SYSTHESIS OF 5-RIBOSYLURIDYLIC ACID R. L. Heinrikson and E. Goldwasser p 62–65 9 refs

11. PROPERTIES OF THE DNA-DEPENDENT SYNTHESIZED RNA S. B. Weiss p 65–70 19 refs

12. STRUCTURE-ACTIVITY CORRELATIONS OF ACTINOMYCINS AND THEIR DERIVATIVES E. Reich, I. H. Goldberg, and M. Rabinowitz, p 71–81 25 refs

13. BASIS OF ACTINOMYCIN ACTION I. H. Goldberg, M. Rabinowitz, and E. Reich p 82–95 26 refs

14. COMPARATIVE UTILIZATION OF PSEUDOURIDINE TRIPHOSPHATE AND URIDINE TRIPHOSPHATE BY RNA POLYMERASE I. H. Goldberg and M. Rabinowitz p 96–110 41 refs

15. GLYCOGEN SYNTHESIS AND OTHER REACTIONS OF PSEUDOURIDINE DIPHOSPHATE GLUCOSE M. Rabinowitz and I. H. Goldberg p 111–121 15 refs

16. STAFF PUBLICATIONS p 122–123 25 refs

N63-18348 California U., Berkeley. Lawrence Radiation Lab.
NEUTRON DEPTH DOSE FROM (α, n) AND (γ, n) SOURCES IN A TISSUE-EQUIVALENT PHANTOM
Henry Aceto, Jr., and Bruce W. Churchill Mar. 4, 1963 39 p 11 refs
(Contract W-7405-eng-48)
(UCRL-10267) OTS: $0.75

Neutron depth-dose behavior in tissue-equivalent phantom exposed to SbBe, PoLi, Po mock fission, and PuBe point sources has been examined with respect to existing theoretical and experimental calculation. Dose from exposure to a point source of complex energy spectra can be estimated by applying a $1/r^2$ geometric correction to the incident neutron flux and comparing the result with the known monoenergetic behavior of neutrons equivalent to the average energy of the point source neutrons. Author

N63-18352 Douglas Aircraft Co., Inc. Missile and Space Systems Div., Santa Monica, Calif.
DESIGN STUDY FOR A CONSOLE SYSTEM
E. B. Konecci, G. W. Hoover, and C. Pruett Feb. 19, 1962 31 p Presented at Symp. on Biomedical Engineering, San Diego, Calif., June 19–21, 1962
(Contract N123-(61756)-24946A(PMR))
(Engineering Paper 1349)

The objective of the study was to establish criteria for the design and development of a real-time psychophysiological and environmental monitoring system for determining the wellbeing and safety of human operators during present high-performance aircraft and guided missile tests and operations, as well as during laboratory simulated and near future space operations. A systematic analysis of the overall requirements was made, followed by an evaluation of the state of the art. From this analysis, an optimum design criterion and an interim design criterion were established. An evaluation of the differences between optimum and interim determines the requirements for further research and development. The application of this approach is discussed. N.E.A.

N63-18374 Schwarz BioResearch, Inc., Orangeburg, N.Y.
SUPERIOR DIET FOR MAN IN SPACE Quarterly Progress Report, Oct. 4, 1962–Jan. 4, 1963
Norman A. Rosenthal Jan. 1963 6 p
(NASA Contract NASw-517)
(NASA CR-50520) OTS: $1.10 ph, $0.80 mf

Critical evaluation of liquid chemically defined diets, as presently constituted, reveals the limitations of present formulations and the need to reformulate a number of new diet preparations. Rat bioassays have been devised, and will be used to ascertain the effects of replacement of specific diet constituents with both biochemically and organoleptically more compatible ingredients. In order to accelerate and simplify the assay procedure for determining the D-isomer present in L-amino acids, a microtechnique involving the use of conway cells has been developed, employing a D-amino acid oxidase. Author

N63-18385 Naval Air Development Center. Aviation Medical Acceleration Lab., Johnsville, Pa.
A THEORY OF ENZYME KINETICS BASED ON ELECTRON CONDUCTION THROUGH THE ENZYMATIC PARTICLES, WITH APPLICATIONS TO CYTOCHROME OXIDASES AND TO FREE RADICAL DECAY IN MELANIN

Freeman W. Cope, May 3, 1963 38 p 21 refs
(Rept. 19; NADC-MA-6306)

A kinetic theory of enzymatic oxidation-reduction has been built considering the enzyme particle to catalyze the oxidation-reduction of two different substrates at two different enzymatic sites on the same particle, with conduction of electrons between the two sites through the enzyme particle. Electron conduction across the solid-liquid interfaces at the two sites is assumed to obey the voltage-current laws valid for electrodes in solution. In analogy with electrode kinetics, separate consideration is given to the situation where the reaction rate is limited by diffusion of substrate up to the enzyme surface, by conduction of electrons across the enzyme particle, or by the activation of electrons from substrate to enzyme across the interface. Diffusion-limited reactions were shown to obey first-order kinetics. Activation limited reactions were shown to have straight 1/v vs 1/s plots like Michaelis–Menton kinetics, but different in that the 1/v-axis intercept was negative when the slope was positive. The eye melanin free-radical reaction conforms to this pattern. Reactions rate-limited simultaneously by diffusion of substrate and by electron conduction were shown to obey first-order kinetics showing a hyperbolic relationship between the first-order rate constant and the total concentration of substrate plus product. The cytochrome oxidase and cytochrome peroxidase reactions have been found to conform to this pattern. Author

N63-18396 General Mills, Inc. Electronics Div., St. Paul, Minn.
EXPLORATION OF THE STRATOSPHERE FOR VIABLE MICROORGANISMS [Research Report] Jan. 1–Dec. 31, 1962
V. W. Greene [1963] 33 p 7 refs Presented at the COSPAR, 4th International Space Science Symp., Warsaw, June 7, 1963
(NASA Contract NASw-648)
(NASA CR-50298; J-1034) OTS: $3.60 ph, $1.19 mf

Two balloon-borne flights to 19.8 km and 27.1 km were conducted in 1962 to sample air volumetrically through filters and to determine the existence and identity of viable microorganisms in the stratosphere. Although a variety of bacteria, yeasts, and molds were recovered from filters exposed at high altitudes, malfunctions of the mechanical equipment and sterile controls limit the conclusions that can be drawn from these experiments. The feasibility of this type of exploration, and the precautions which must be taken are discussed. Author

N63-18438 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
BIOLOGICAL INVESTIGATIONS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 76–79 (See N63-18430 17-32)

Biological studies on living organisms aboard high altitude rockets and satellites are conducted to gain knowledge that will aid man in his efforts to travel in space. The factors investigated include: the state of weightlessness under free flight conditions; the effect of various radiations on living organisms; the state of highly organized living beings in a hermatic cabin; and the adaptability of a living organism to a space environment. J.R.C.

N63-18447 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
BIOLOGICAL INVESTIGATIONS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 155–158 (See N63-18430 17-32)

A medical–biological experiment was carried out on the second Soviet manmade satellite to study the vitality of a living organism under conditions of cosmic flight and, in particular, a state of weightlessness. The satellite was provided with an airtight (pressurized) cabin occupied by an experimental dog. Data on the behavior and condition of the animal on the orbiting section of the satellite, the characteristic of which is the presence of large overloads, as well as vibrations and noise from the operating power plant, are described. These data showed that the flight along the orbiting section was endured by the animal with satisfaction. No essential and permanent changes in the physiological functions of the animal resulted from the state of weightlessness. N.E.A.

N63-18452 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
MEDICAL-BIOLOGICAL PROBLEMS OF MAN'S FLIGHT INTO COSMIC SPACE
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 233–236 (See N63-18430 17-32)

To solve problems concerning adequate medical protection when man flies in cosmic space, it became necessary to: (1) investigate the effect of cosmic flight factors on the organism, and to investigate the possible forms and method of protection against the unfavorable effects of these factors; (2) develop most effectively methods of securing normal living conditions for the person in the cabin of the cosmic ship; and (3) develop methods for medical selection and training of cosmic ship crew members, and develop a system of constant medical control over the state of health and activities of cosmonauts during all stages of flight. The use of various kinds of animals and plants allowed for a full and detailed investigation of the effect of cosmic flight conditions, i.e., weightlessness, overload, and radiation, on the most variegated processes and functions of organisms. These experiments were carried out on special ground stands under laboratory conditions and in rocket flights, such as the second Soviet manmade earth satellite and the first Soviet ship-satellite. Results of medicobiological investigations on cosmic ship-satellites, and laboratory tests indicate that man can endure spaceflight conditions without ill effects to his health. N.E.A.

N63-18495 Rand Development Corp., Cleveland, Ohio
A STUDY ON DYNAMIC SYSTEMS RESPONSE OF THE PERFORMANCE CHARACTERISTICS OF SOME MAJOR BIOPHYSICAL SYSTEMS First Quarterly Report
A. S. Iberall and S. Z. Cardon July 1963 129 p 97 refs
(NASA Contract NASw-678)
(NASA CR-50548) OTS: $10.10 ph, $4.07 mf

The status of regulation and control in biological systems is reviewed. The following are covered: (1) identification and limitation of the watery interior of the body, as the physical field in which the biological materials, mechanisms, and processes operate and exhibit their performance, (2) the major material constituents of the interior and many of the processes and mechanisms that are regulated, (3) the salient role of the kidney in regulating the material constituents of the watery interior, (4) the computer control nature of the brain, operating through a digital computer-like communications net complex, and (5) sustained efforts to find a communications logic for the neutral nets. P.V.E.

N63-18636 North American Aviation, Inc., Los Angeles, Calif.
MOMENTS OF INERTIA AND CENTERS OF GRAVITY OF THE LIVING HUMAN BODY [Final Report, Feb.–Aug. 1962]
W. R. Santschi, J. Du Bois, and C. Omoto Wright-Patterson AFB, Ohio, Behavioral Science Lab., May 1963 65 p 11 refs
(Contract AF 33(657)-7848)
(AMRL-TDR-63-36) OTS: $1.75

A study was conducted to determine the moments of inertia and centers of gravity of a sample of 66 living male subjects representative of the Air Force population in stature and weight. Eight body positions were investigated: standing; standing, arms over head; spread eagle; sitting; sitting, forearms down; sitting, thighs elevated; mercury configuration; relaxed (weightless). The procedure was based upon the compound pendulum having a theoretical accuracy of approximately ±2 to ±8 percent depending upon position and axis. Orthogonal axes, defined as the intersections of the sagittal, frontal, and transverse planes through the standing body, were designated as X, Y, and Z. A set of 50 anthropometric dimensions was taken on each subject, as well as photographs of each subject in each position. Results of the study show that the average moment of inertia varied in this sample from 11 lb in sec^2 about the Z axis to 152 lb in sec^2 about the X axis. Linear regression analysis of moments of inertia vs. stature and weight yielded correlation coefficients ranging between 0.77 and 0.98. Author

N63-18673 Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.
AEROMEDICAL EVALUATION FOR SPACE PILOTS
Lawrence E. Lamb, ed. July 1963 278 p refs

This report covers the following phases in the aeromedical evaluation of space test pilots: (1) the detection of significant disease processes or abnormalities; (2) findings that show a person may be predisposed to disease or that his performance capability may be limited; (3) the assessment of mental and character dynamics; and (4) the capacity to withstand physiological stresses. Included in this report are findings from integrated medical examinations of the first group of space test pilots. I.v.L.

N63-18677 Harvard U. Medical School, Boston, Mass.
AUTONOMIC CONTROL OF CIRCULATION DURING THE HIBERNATING CYCLE IN GROUND SQUIRRELS
C. P. Lyman and Regina C. O'Brien Ft. Wainwright, Alaska, Arctic Aeromedical Lab., Feb. 1963 35 p 23 refs
(Contract AF 41(657)-380)
(AAL-TDR-62-39)

The control of circulation in undisturbed *Citellus tridecemlineatus* and *C. lateralis* has been studied during all phases of the hibernating cycle by infusing drugs of known pharmacological effect into the bloodstream via chronically implanted aortic cannulae and by monitoring pulse pressure. It is concluded that the parasympathetic system has a regulatory, but not essential, effect on the heart rate as the animal enters hibernation. During hibernation, the heart and circulation are virtually impervious to parasympathetic influence, and, during arousal, the parasympathetic system has no detectable effect. Decline in sympathetic activity contributes to the slowing of the heart during entrance into hibernation, but sympathetically mediated vasoconstriction maintains peripheral resistance which is essential for life in hibernation. During hibernation, skeletal muscle is extremely sensitive to the nicotinic effects of acetylcholine and methacholine, but the heart is impervious to parasympathetic effects. Muscle action potentials, either induced nicotincally or by physical stimulation, may initiate the cardioacceleration of arousal via sympathetic fibers. During arousal, sympathetic activity is essential to mediate the precisely timed vascular changes which aid in restoring the animal to the warm-blooded state. Author

N63-18729 Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.
A 30-DAY STUDY OF CHIMPANZEE PERFORMANCE ON A SELF-PACED TASK FOR FOOD AND WATER
Frederick H. Rohles, Jr., Herbert H. Reynolds, and Marvin E. Grunzke May 1963 14 p 5 refs
(ARL-TDR-63-15)

Three chimpanzees were trained to press a lever 50 times to turn on two lights. If the animal desired food reward, a lever in front of the first light was pressed; and if water was preferred, a lever in front of the second light was pressed. Then each animal was isolated for 30 days and permitted to establish its own work–rest cycle on this performance task, which was on continually for the 30-day period. Evidence of circadian rhythms was found, with heightened activity occurring at 0700 in the morning and lowered activity at 1800 in the afternoon. None of the subjects showed any marked physical effects following the experiment. Author

N63-18744 Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.
MEDICAL DIVISION RESEARCH REPORT FOR 1962
Gould A. Andrews et al [1962] 72 p 18 refs
(Contract AT(40-1)-GEN-33)
(ORINS-42) OTS: $1.75

This review covers: (1) radiation effects and treatment; (2) medical nuclides; (3) diagnostic and therapeutic radioisotopes; (4) tracer and basic biological studies; (5) the use of aluminum plates for thin-layer chromatography; (6) the use of a linear scanner for rapidly screening radioisotopic distribution in small animals; and (7) radiation physics and related instrumentation. I.v.L.

N63-18774 California U., Berkeley. Lawrence Radiation Lab.
BIOLOGY AND MEDICINE – SEMIANNUAL REPORT, FALL 1962
John H. Lawrence and Tove Neville, eds. Dec. 1962 188 p 404 refs
(Contract W-7405-eng-48)
(UCRL-10683) OTS: $2.75

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3. NORMAL IRON ABSORPTION IN MAN H. Saito, T. W. Sargent, and H. G. Parker p 19–31 19 refs

4. WHOLE-BODY IRON LOSS IN MAN H. Saito, T. W. Sargent, H. G. Parker, and J. H. Lawrence p 32–37 8 refs

5. NORMAL RESPONSE TO ERYTHROPOIETIN OR HYPOXIA IN RATS MADE ANEMIC WITH TURPENTINE ABSCESS A. Gutnisky and D. Van Dyke p 38–43 14 refs

6. PRELIMINARY RESULTS FROM THE USE OF ERYTHROPOIETIN IN HUMAN VOLUNTEERS D. Van Dyke, J. H. Lawrence, M. Pollycove, and P. Lowy p 44–53 12 refs

7. IMMUNOLOGICAL NEUTRALIZATION OF VARIOUS ERYTHROPOIETINS J. F. Garcia and J. C. Schooley p 54–58 5 refs

8. CORRELATION BETWEEN ERYTHROPOIETIN TITER, EVIDENCE OF TISSUE HYPOXIA AND HEMOGLOBIN SYNTHESIS IN A NORMAL HUMAN VOLUNTEER ACUTELY EXPOSED TO HYPOXIA W. E. Siri, D. Van Dyke, H. S. Winchell, M. Pollycove, and H. G. Parker p 59–74 13 refs

9. GRADIENT-ELUTION CHROMATOGRAPHY OF RAT-BRAIN-LIPID EXTRACTS G. J. Nelson p 75–90 42 refs

10. SIMULTANEOUS DETERMINATION OF CHOLESTERYL ESTERS AND TRIGLYCERIDES IN SERUM LIPIDS BY INFRARED SPECTROPHOTOMETRY N. K. Freeman p 91–97 10 refs

11. ANALYSIS OF LOW-DENSITY LIPOPROTEINS BY PREPARATIVE ULTRACENTRIFUGATION AND REFRACTOMETRY F. T. Lindgren, A. V. Nichols, R. D. Will, L. Wing, and J. E. Gullberg p 98–106 15 refs

12. "VACUUM SENTINELS" FOR PREPARATIVE AND ANALYTICAL ULTRACENTRIFUGES F. T. Lindgren and F. T. Upham p 107–109 5 refs

13. A QUANTITATIVE DETERMINATION OF THE OSMIUM-TETROXIDE-LIPOPROTEIN INTERACTION T. L. Hayes, F. T. Lindgren, J. W. Gofman, S. W. Spaulding, and J. P. World p 110–113 9 refs

14. INFLUENCE OF THE THYMUS ON THE OUTPUT OF THORACIC-DUCT LYMPHOCYTES J. C. Schooley and L. S. Kelly p 114–130 36 refs

15. THYROID FUNCTION IN CHICKEN AND RAT. I. THE EFFECT OF IODINE CONTENT OF THE DIET AND OF HYPOPHYSECTOMY ON IODINE METABOLISM IN WHITE LEGHORN COCKERELS L. L. Rosenberg, M. K. Dimick, and G. La Roche p 131–151 29 refs

16. THYROID FUNCTION IN CHICKEN AND RAT. II. THE EQUILIBRATION OF INJECTED IODIDE WITH EXISTING THYROIDAL IODINE IN CHICKEN L. L. Rosenberg, G. La Roche, and M. K. Dimick p 152–161 16 refs

17. DIFFERENTIATION BETWEEN VITAMIN-B_{12}- AND FOLIC-ACID-DEFICIENT MEGALOBLASTIC ANEMIAS WITH C^{14}-HISTIDINE M. B. Fish, M. Pollycove, and T. V. Feichtmeir p 162–175 49 refs

18. AUTORADIOGRAPHIC EVIDENCE FOR A PLURIPOTENTIAL STEM CELL IN THE BONES MARROW J. C. Schooley and K. Giger p 176–179 6 refs

19. Staff Publications p 180–182 38 refs

17 MACHINE ELEMENTS AND PROCESSES

Includes: bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; and materials fabrication, handling, and inspection.

For related information see: 06 Auxiliary Systems.

N63-18213 Lockheed Missiles and Space Co., Sunnyvale, Calif.
COMPOSITE MATERIALS: AN ANNOTATED BIBLIOGRAPHY, SUPPLEMENT I [SEPTEMBER 1962-JUNE 1963]
Helen M. Abbott, comp. June 1963 54 p 90 refs
(SB-63-49)

This annotated bibliography contains 90 selected references pertaining to composite materials. Spaceflight and supersonic aircraft have made great demands for composite materials that can be used for applications that require performance characteristics not obtainable with conventional materials.
Author

N63-18251 Defense Metals Information Center, Battelle Memorial Inst., Columbus, Ohio
A GUIDE TO THE LITERATURE ON HIGH-VELOCITY METALWORKING
D. E. Strohecker and D. H. Owens Dec. 3, 1962 250 p 829 refs
(Contract AF 33(616)-7747)
(DMIC-179; supersedes NA62H-46-ORD-241; AD-276693)

This report is a guide to the literature on high-velocity metalworking. It consists primarily of abstracts of articles, reports, books, and current research projects on and related to high-velocity metalworking, arranged according to technical subject. It covers a survey of the reported work in the field up to about October, 1962.
Author

N63-18283 Rock Island Arsenal Lab., Ill.
GALVANIC PROTECTION BY METAL SPRAY METHOD Technical Report
J. Knanishu May 1, 1963 47 p 6 refs
(RIA-63-1419) OTS: $1.25

The metal flame-spray method of application was used to develop techniques whereby bimetal junctions may be treated with an optimum coating to combat galvanic corrosion. Steel, aluminum, and magnesium panels, as well as steel, aluminum, magnesium, stainless steel, and copper "buttons" were used in making up the corrosion couples. A successful procedure to produce reliable adhesion was developed. Where good adhesion procedures were maintained, excellent galvanic corrosion resistance resulted. Pure tin metal-sprayed coatings proved superior, generally, to aluminum (5056) metal-sprayed coatings as a guard against galvanic corrosion. Corresponding test panels were exposed in the 5% salt-spray (fog) cabinet and outdoors. There was a correlation between the results obtained in the salt-spray (fog) test and the outdoor test.
Author

N63-18320 Pratt and Whitney Aircraft, East Hartford, Conn.
DETERMINATION OF THE EMISSIVITY OF MATERIALS Quarterly Progress Report, Oct. 1 through Dec. 31, 1962
R. J. Hayes 1963 96 p
(NASA Contract NASw-104)
(NASA CR-50487; PWA-2163) OTS: $8.60 ph, $3.08 mf

Emittance measurements are reported on fifteen materials. These fifteen materials are stannic oxide, silicon dioxide, palladium black, nickel oxide, chromic oxide, cobalt oxide, boron carbide, iron–titanium oxide, iron–titanium–aluminum oxide, oxidized kennametal K-151-A, titania, calcium titanate, strontium titanate, silicon carbide, and manganese oxide. All coatings were bonded to columbium–1 percent zirconium substrates, except palladium black and oxidized kennametal K-151-A, which were bonded to AISI-310 stainless steel. Two grades of titania were tested to determine the effects of purity on emittance. The total hemispherical emittance of all materials were measured over a range of temperatures. In addition, the spectral normal emittances of boron carbide, iron–titanium oxide, the higher purity titania, and silicon carbide were measured. Iron–titanium–aluminum oxide, strontium titanate, and silicon carbide were subjected to short term endurance testing. The total hemispherical emittance of strontium titanate was measured in all three emittance rigs for comparison purposes.
Author

N63-18323 General Electric Co. Advanced Technology Labs., Schenectady, N.Y.
DESIGN CRITERIA FOR ZERO-LEAKAGE CONNECTORS FOR LAUNCH VEHICLES, VOLUME 6 – ENVIRONMENTAL EFFECTS Final Report, Mar. 1962-Feb. 1963
S. Levy, ed. Mar. 15, 1963 130 p 13 refs
(NASA Contract NAS8-4012)
(NASA CR-50562) OTS: $10.10 ph, $4.10 mf

To determine design criteria for zero-leakage connectors for launch vehicles, the effects of the following are considered: (1) fluid heat transfer coefficients, (2) radial heat flow through a surface film into a circular flange, (3) temperature transients in bolts, and (4) temperature transient analysis in flange assemblies.
B.J.C.

N63-18358 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report No. 8 for Aug. 1962 [BEARING YIELD AND LIFE IMPROVEMENT PROGRAM AND THE THERMOELECTRIC-COOLING PROGRAM]
Alfred C. Edwards Sept. 1962 18 p 2 refs
(Contract AF 33(657)-7463)
(E-1214)

Technological developments, problem areas, and future plans are presented for the bearing yield and life-improvement program, and the thermoelectric-cooling program. Considered under the bearing yield and life-improvement program are: (1) production of improved-tolerance baseline bearings, (2) test-equipment procurement, (3) base-line-bearing screening test, (4) development and screening of lubricants and lubrication-control mechanisms, (5) development and screening of ball-retainer materials, (6) determination of optimum mechanical interface finishing processes by screening, (7) retainer dynamic behavior, (8) pretreatment of metal surfaces with organic coatings, (9) lubricant improvement, and (10) accelerated life testing. Under the thermoelectric-cooling program, progress is reported on basic investigations and preliminary thermoelectric-cooling tests, and effect of temperature on bearing life and performance. N.E.A.

N63-18359 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge, Mass.
Monthly Progress Report No. 10 for October, 1962 [BEARING YIELD AND LIFE-IMPROVEMENT PROGRAM AND THE THERMOELECTRIC-COOLING PROGRAM]
Alfred C. Edwards Nov. 1962 31 p 3 refs
(Contract AF 33(657)-7463)
(E-1249)

Technological developments, problem areas, and future plans are presented for the bearing yield and life-improvement program and the thermoelectric-cooling program. Considered under the bearing yield and life-improvement program are: (1) base-line and accelerated performance tests and design and fabrication of test bearings; (2) test-equipment procurement; (3) development and screening of ball-retainer material; (4) development and screening of lubrication control mechanism; (5) determination of optimum, mechanical interface-finishing processes by screening; (6) screening parameter variations by means of single-bearing test devices; (7) design and fabrication of improved bearings; (8) retainer dynamic behavior; (9) pretreatment of metal surfaces with organic coatings; (10) lubricant improvement; and (11) accelerated life testing. Basic investigations and preliminary thermoelectric-cooling tests, effect of temperature on bearing life and performance, and evaluation of the application of thermoelectric-cooling techniques to gyro units and other aerospace equipment are discussed under the thermoelectric-cooling program. N.E.A.

N63-18365 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report 12 for 1962 [BEARING YIELD AND LIFE-IMPROVEMENT PROGRAM AND THE THERMOELECTRIC-COOLING PROGRAM]
Alfred C. Edwards Jan. 1963 20 p 2 refs
(Contract AF 33(657)-7463)
(E-1276)

Technical efforts, problem areas, and future plans are reported for the bearing yield and life-improvement program and thermoelectric-cooling program. Discussed under the bearing yield and life-improvement program are: (1) base-line and accelerated performance tests and design and fabrication of test bearings; (2) development and screening of ball-retainer materials; (3) development and screening of lubricants and lubrication-control mechanisms; (4) determination of optimum mechanical interface finishing processes by screening; (5) retainer dynamic behavior; (6) lubricant improvement; and (7) accelerated life testing. The following are reported on the thermoelectric-cooling program: (1) basic investigations and preliminary thermoelectric-cooling tests; (2) effect of temperature on bearing life and performance; and (3) evaluation of the application of thermoelectric-cooling techniques to gyro units and other aerospace equipment. N.E.A.

N63-18366 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report II for 1962 [BEARING YIELD AND LIFE-IMPROVEMENT PROGRAM AND THE THERMOELECTRIC-COOLING PROGRAM]
Alfred C. Edwards Dec. 1962 37 p 1 ref
(Contract AF 33(657)-7463)
(E-1266)

Technical efforts, problem areas, and future plans are reported for the bearing yield and life-improvement program and the thermoelectric-cooling program. The following are discussed under the bearing yield and life-improvement program: (1) base-line and accelerated performance tests and design and fabrication of test bearings; (2) development and screening of ball-retainer materials; (3) test equipment procurement; (4) development and screening of lubricants and lubrication-control mechanisms; (5) determination of optimum mechanical interface finishing processes by screening; (6) retainer dynamic behavior; (7) pretreatment of metal surfaces with organic coatings; (8) lubricant improvement; and (9) accelerated life testing. Basic investigations and preliminary thermoelectric-cooling tests, effect of temperature on bearing life and performance, and evaluation of the application of thermoelectric-cooling techniques to gyro units and other aerospace equipment are reported for the thermoelectric-cooling program. N.E.A.

N63-18390 General Electric Co. Advanced Technology Labs., Schenectady, N.Y.
DESIGN CRITERIA FOR ZERO-LEAKAGE CONNECTORS FOR LAUNCH VEHICLES. VOLUME I, SUMMARY, CONCLUSIONS, AND DESIGN EXAMPLES Interim Report, Mar. 1962-Feb. 1963
T. P. Goodman, ed. Mar. 15, 1963 65 p 15 refs
(NASA Contract NAS8-4012)
(NASA CR-50557) OTS: $6.60 ph, $2.15 mf

The goal of this investigation is to establish the fundamental design criteria that will provide for zero leakage in separable connectors used in launch vehicles. The approach taken in the investigation has been to regard a separable connector as an interface between two surfaces, backed up by a supporting structure, designed to withstand a variety of environmental conditions. The project has included both analytical and experimental investigation of the sealing action at the seal interface, together with analytical investigation of the supporting structure and the environmental conditions to which a launch vehicle is subject. The application of design criteria is illustrated by three representative design examples. The principal conclusions from this investigation are: (1) Substantial plastic flow of at least one of the materials at the seal interface is necessary for zero leakage. (2) The plastic flow required for zero leakage can never be achieved in a conventional flared fitting with metal-to-metal contact, because the fitting will fail by hoop compression before the plastic stress range is reached at the seal interface. (3) To reduce the effect of flange rolling in the larger sizes of bolted flanged connectors, efficient lightweight designs can often be obtained by having

the flanges in contact outside the bolt circle. (4) The many interacting factors in connector design can best be evaluated by building and testing connectors for specific applications. Author

N63-18391 General Electric Co. Advanced Technology Labs., Schenectady, N.Y.
DESIGN CRITERIA FOR ZERO-LEAKAGE CONNECTORS FOR LAUNCH VEHICLES. VOLUME 5, PRESSURE ENERGIZED SEALS Final Report, Mar. 1962-Feb. 1963
B. T. Fang, ed. Mar. 15, 1963 116 p 10 refs
(NASA Contract NAS8-4012)
(NASA CR-50561) OTS: $9.60 ph, $3.68 mf

Pressure-energized static seals are used between the flanges of a flanged joint to form a leak-tight seal between the flanges, and maintain this seal as the internal pressure is increased and the flanges tend to separate. The geometry and materials of many of the seals used in the missile industry are similar enough to allow their analysis, using a small number of generalized mathematical models. Each model is analyzed and curves of its characteristics calculated for a set of typical dimensions. Author

N63-18416 General Dynamics/Ft. Worth, Tex.
HIGH TEMPERATURE PROTECTIVE COATINGS DEVELOPMENTS AT GENERAL DYNAMICS/FORT WORTH
P. F. Ghena and J. E. Burroughs [1963] 14 p Presented at the Refractory Composites Working Group Meeting, Palo Alto, Calif., Mar. 11–14, 1963
(Sponsored by NASA-ASD)
(NASA CR-50540) OTS: $1.60 ph, $0.80 mf

The development and evaluation of a slurry-dipped intermetallic coating (Sylcor type) for elevated-temperature oxidation protection of tantalum and niobium alloys, subjected to reentry vehicle environments, are reviewed. The thermal environment considered was 5 hours at 3300° F for the tantalum alloy and 20 hours at 2300° F for the niobium alloy. Results thus far, though incomplete, indicate that a composition between 50 Al-50 Sn and 25 Al-75 Sn will produce the optimum coating for the tantalum and niobium alloys. I.v.L.

N63-18424 Massachusetts Inst. of Tech. Instrumentation Lab., Cambridge
Monthly Progress Report for February 1963 [BEARING YIELD AND LIFE-IMPROVEMENT PROGRAM AND THE THERMOELECTRIC COOLING PROGRAM]
Alfred C. Edwards Mar. 1963 16 p
(Contract AF 33(657)-7463)
(Rept. 14; E-1317)

Investigations into the bearing yield and life-improvement program are presented. Progress is reported on the design, fabrication, and accelerated performance tests of test bearings; on development and screening of ball retainer materials along with retainer dynamic behavior; on improvement, development, and screening of lubricants and lubricant control mechanisms; on optimum mechanical interface finishing processes by screening; on screening of parameter variations by means of single bearing test devices; and on pretreatment of metal surfaces with organic coating. C.L.W.

N63-18493 General Electric Co. Advanced Technology Labs., Schenectady, N.Y.
DESIGN CRITERIA FOR ZERO-LEAKAGE CONNECTORS FOR LAUNCH VEHICLES. VOLUME 2: LEAKAGE FLOW Final Report, Mar. 1962 through Feb. 1963
T. P. Goodman, ed. Mar. 15, 1963 59 p 3 refs
(NASA Contract NAS8-4012)
(NASA CR-50558) OTS: $5.60 ph, $1.97 mf

"Zero leakage" has a much more stringent meaning in rocket propulsion systems than in the more conventional technologies such as steam-powerplant design. In a rocket propulsion system, it is not sufficient simply to have "stable leakage" or "leakage by molecular diffusion only." In rocket systems, zero leakage as determined from a bubble test means leak rates less than 10^{-4} atm cc/sec or 10^{-6} lb of air per hour; however, laboratory measurements with mass-spectrometer leak detectors can detect leaks of one-millionth of this magnitude. Leakage by diffusion through solid walls is generally well below zero leakage as determined by a bubble test, though still readily detectable by mass-spectrometer measurements. Author

N63-18494 General Electric Co. Advanced Technology Labs., Schenectady, N.Y.
DESIGN CRITERIA FOR ZERO-LEAKAGE CONNECTORS FOR LAUNCH VEHICLES. VOLUME 4: DESIGN OF CONNECTORS Final Report, Mar. 1962 through Feb. 1963
S. Levy, ed. Mar. 15, 1963 183 p 3 refs
(NASA Contract NAS8-4012)
(NASA CR-50560) OTS: $13.00 ph, $5.69 mf

A review of available design procedures for the many environmental factors affecting the performance of connectors is presented. Details of some of the specific design considerations are discussed: (1) interaction of flanges, gaskets, and pipes; (2) design of large-diameter lightweight flanges having contact outside the bolt circle; (3) flange joints without contact outside the bolt circle; (4) bolt spacing; (5) cryogenic connector considerations; (6) effect of creep on flange connectors; (7) bolt force to flatten warped flanges; (8) effect of bending moment and misalignment on flange connectors; (9) thermal distortion of flanges; and (10) analysis of flare-type tubing connectors. N.E.A.

N63-18661 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ACHIEVING SATELLITE RELIABILITY THROUGH ENVIRONMENTAL TESTS
John C. New Washington, NASA, July 1963 29 p 3 refs Presented at Inst. of Environmental Sci., Los Angeles, Apr. 17–19, 1963
(NASA TN D-1853) OTS: $0.75

The principles, policies, and procedures used by NASA in achieving satellite reliability by exploiting environmental-testing techniques are described. The formalized environmental-test plan for a typical satellite program is reviewed to illustrate these objectives. A discussion that highlights the reliability objectives of space missions as contrasted with military or industrial missions is given. Actual experience gained by utilization of this program is shown by results obtained with several scientific satellites that have been successfully orbited. Author

N63-18732 Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.
GAS PRESSURE BONDING OF PRODUCTION SIZE PWR CORE 2 PLATE TYPE FUEL ELEMENTS CONTAINING CERAMIC FUEL
F. O. Bingman and C. R. Woods May 1963 126 p 8 refs
(Contract AT(11-1)-GEN-14)
(WAPD-245) OTS: $2.50

Several production-size PWR Core 2 plate-type fuel elements were fabricated and evaluated to establish the optimum parameters to yield acceptable fuel elements by the gas-pressure bonding process. The evaluation included the effect

of a post-bonding heat treatment, assembly clearance and bonding temperature on the bond quality, fuel clad reaction, surface smoothness, overall dimensions, corrosion resistance of the fuel element, and the mechanical properties of the individual compartments. The results of the evaluation indicate that acceptable production-size fuel elements are attained when the indicated fabrication variables are maintained within reasonable operative limits. Author

18 MATERIALS, METALLIC

Includes: cermets; mechanical and physical properties of alloys and metals; and metallurgy.

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Non-metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-18231 General Electric Co. Large Steam Turbine-Generator Dept., Schenectady, N.Y.
CAST Ni BASE ALLOYS FOR 1150F SERVICE
J. R. Pedersen and C. D. Walker Sept. 28, 1962 113 p 6 refs
(DF62SL322)

Two series of cast, nickel-base alloys were evaluated for 1150F service. One series was based on 50% Ni – 15% Cr, the other 65–75% Ni – 15% Cr. A study was made of the effects of varying the amounts of Al, Cb, Ti, Mo, W, Mn, and Ni on the mechanical properties, aging response, and microstructure. In addition, the effects of various heat treatments on structure as well as some mechanical properties were studied. Conclusions are as follows: (1) Alloys at both the 50% and 65% nickel levels were developed with yield strengths in excess of 50,000 psi and 10^5 hour, 1150F rupture strengths ranging from 30 to 40,000 psi. Further, based on compostition, it is possible to predict the yield and rupture strength within reasonable limits. (2) Cb and Al and possibly Ti appear to be interchangeable on an atomistic basis relative to their effect on the increase in yield strength (i.e., γ'reaction), which varies in a linear fashion with the amounts of these elements for the limits evaluated. (3) The rupture ductility of the 50% nickel alloys is significantly better than the 65% nickel alloys. The difference appears to be related, at least in part, with the formation of Laves phase in the lower nickel alloys. Substituting Cb for Al favors ductility. Author

N63-18267 Hanford Atomic Products Operation, Richland, Wash.
NEUTRON IRRADIATION AND COLD WORK EFFECTS ON ZIRCALOY-2 CORROSION AND HYDROGEN PICKUP
Interim Report
W. A. Burns and H. P. Maffei Dec. 1962 32 p 18 refs
(Contract AT(45-1)-1350)
(HW-76636)

Corrosion weight gains and hydrogen sorption for Zircaloy-2 specimens exposed to similar aqueous and thermal environments in- and out-of-reactor were compared to obtain quantitative information relative to the effects of a high-energy neutron flux on the processes involved. Metal specimens representing four levels of cold work were exposed in high-quality water at 540° F to fast-neutron flux intensities over the range 1.7 to 4.2 × 10^{13} nv (> 1.0 Mev.) and to a maximum integrated fast flux of 1.06 × 10^{20} nvt. In-reactor weight gains were found to be higher by an order of magnitude, and a saturation effect of flux was indicated. No significant effects of work history on corrosion were observed. Fractional pickup of corrosion hydrogen in-reactor was within the range normally expected for out-of-reactor exposure, but a trend toward reduced pickup of hydrogen by material cold worked to the extent of about 10% was observed. No effect of cold work on hydrogen pickup was observed for unirradiated specimens. Author

N63-18312 National Aeronautics and Space Administration, Washington, D.C.
TUNGSTEN AND MOLYBDENUM
Curt Agte and Jiri Vacek 1963 295 p 410 refs Transl. of the book "Wolfram a Molybden", State Publishing House of Tech. Lit., Prague, 1954
(NASA TT F-135) GPO: $1.00

The production of tungsten and molybdenum by powder metallurgy is considered. Discussed are: (1) tungsten and molybdenum occurrence; (2) extracting tungsten and molybdenum from ores, concentrates, and extraneous products; (3) refining tungstic and molybdic acids for production of ductile metal; (4) industrial methods of producing ductile semiproducts from tungsten and molybdenum; (5) working tunsten and molybdenum into ductile semiproducts; (6) production and working of highly sinterable tungsten; (7) properties of tungsten and molybdenum; (8) tungsten and molybdenum metallography; (9) alloys of tungsten and molybdenum; (10) technical uses of tungsten and molybdenum. N.E.A.

N63-18383 Argonne National Lab., Ill.
A STUDY OF THE THERMODYNAMIC PROPERTIES OF THE VANADIUM-IRON ALLOY SYSTEM
Kevin Michael Myles Feb. 1963 60 p 81 refs
(Contract W-31-109-eng-38)
(ANL-6657)

The vapor pressure of iron over vanadium–iron alloys has been measured by the torsion effusion method in the temperature range from 1500° to 1700° K. The chemical activities, as well as the free energies, entropies, and enthalpies of formation, of the alloys have been computed from the vapor-pressure data. The activities of iron exhibit large negative deviations from Raoult's law throughout the entire compositional range. Although the activities of vanadium, as determined by the Gibbs–Duhem relation, deviate negatively from ideal behavior in the iron-rich alloys, nearly ideal behavior is observed in the vanadium-rich alloys. Large, positive excess entropies and enthalpies of formation are found at 1600° K. An attempt is made to interpret these quantities in terms of the various configurational, vibrational, and magnetic changes that occur in this system upon alloying. Author

N63-18389 Advanced Metals Research Corp., Somerville, Mass.
PROPERTIES OF NON-STOICHIOMETRIC METALLIC CARBIDES Final Report
John T. Norton and Robert K. Lewis Mar. 29, 1963 45 p 10 refs

(NASA Contract NASr-98)
(NASA CR-50321) OTS: $4.60 ph, $1.55 mf

The present work is concerned with carbides of the Group IV metals. The lattice parameter-composition relationship for the cubic TiC phase has been determined which shows a maximum value at $TiC_{0.85}$ of 4.3305A. The maximum carbon content of this phase corresponds to $TiC_{0.95}$. The production of dense high-purity bodies of titanium and zirconium carbide bodies of a range of carbon contents has been examined by

sintering and zone-melting techniques. Dense polycrystalline bodies can be produced by an activated sintering technique, but induction zone melting is required for large monocrystalline specimens. Author

N63-18397 General Electric Co. Flight Propulsion Lab. Dept., Cincinnati, Ohio
EVALUATION OF A HIGH STRENGTH COLUMBIUM ALLOY (AS-55) FOR ALKALI METAL CONTAINMENT Quarterly Report No. 1 Nov. 25, 1961-Feb. 25, 1962
[1962] 52 p
(NASA Contract NAS3-2140)
(NASA CR-50339) OTS: $5.60 ph, $1.76 mf

This investigation was undertaken to obtain additional documentation of the AS-55 columbium alloy as an alkali-metal containment material for nuclear turboelectric space power systems. The objectives of the program are: (1) to investigate the arc melting characteristics of the alloy in order to provide material of high quality for evaluation; (2) to obtain additional data on the fabricability, weldability, and mechanical behavior, particularly the long-time stress-rupture properties; and (3) to investigate the corrosion resistance to potassium under refluxing conditions. The AS-55 represents columbium base alloys with 5% to 10% W, 0.8% to 1.2% Zr, and 0.04% to 0.08% C which are melted with additions of 0.2% to 1% Y to the electrode, much of the yttrium being removed during melting. Based on initial tests, the AS-55 alloy possesses good elevated temperature strength, is readily fabricated and welded, and is resistant to attack from potassium. N.E.A.

N63-18398 Midwest Research Inst., Kansas City, Mo.
INFLUENCE OF SURFACE COATINGS ON EXO-ELECTRON EMISSION DURING FATIGUE Quarterly Progress Report No. 7, Mar. 1-June 1, 1963
J. C. Grosskreutz and David Benson [1963] 9 p
(NASA Contract NASr-63(02))
(NASA CR-50477) OTS: $1.10 ph, $0.80 mf

Progress reported is as follows: (1) An electron multiplier system which is ruggedized and contains integral voltage dividing resistors was obtained. The entire system is bakeable and is unharmed by exposure to the atmosphere. The fatigue testing chamber was modified in order to obtain the required vacuum, since this multiplier requires a vacuum of 10^{-5} torr or better in order to operate reliably. A vac-ion getter pump now replaces the vapor and rotary pumps; thus the new system avoids the difficulties of pump oil contamination. The system is still limited to a pressure of about 2×10^{-5} torr, which is the vapor pressure of the rubber O-rings used in the system. (2) Apparatus for stripping the oxide layer from aluminum was designed and constructed. Hydrogen is admitted to the apparatus and is dissociated into atomic hydrogen by passing over a hot filament. A thermocouple monitors the temperature of the thermally isolated aluminum sample. I.v.L.

N63-18411 Franklin Inst. Labs. for Research and Development, Philadelphia
THE EFFECT OF NUCLEATION OF SURFACE SLIP ON THE FLOW AND FRACTURE OF BERYLLIUM Quarterly Progress Report, Jan. 22, 1963-Apr. 21, 1963
K. Snowden and J. Zeiger 1963 16 p 8 refs
(NASA Contract NASr-145)
(NASA CR-50420; Q-B2028-2) OTS: $1.60 ph, $0.80 mf

The limited number of experiments carried out suggests the following tentative conclusions: (1) Annealing the as-received hot-pressed Be rod at 750° to 850° C, either in vacuum or in argon, doubles the ductility, reduces the microyield stress from 8 to 1.7 Kg/mm^2, and lowers the flow stress. (2) The frictional force opposing the movement of dislocations in the annealed, sprinkled, or Cu-plated specimens was estimated to be 1.5 to 2.0 kg/mm^2. (3) Surface damage introduced by sprinkling an annealed specimen with carborundum powder produced only slight changes in the stress–strain curve compared with that of the annealed specimen. (4) The presence of a Cu-electrodeposited layer reduced the ductility by 25% compared to the uncoated annealed specimen. (5) Prior cyclic straining of an as-received specimen limited the ductility in a subsequent tensile test to one half of that of the as-received specimen, and to one third of that of the as-annealed specimen. (6) The apparent value of Young's modulus of polycrystalline Be was measured in the microstrain region near zero stress and found to be 30,000 Kg/mm^2, which is in good agreement with values published in the literature. Author

N63-18420 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
MAGNETIC CHARACTER OF VERY THIN PERMALLOY FILMS
F. B. Humphrey Repr. from J. Appl. Phys., v. 34, no. 4 (Pt. 2), Apr. 1963 p 1067–1068 13 refs
(NASA Contract NAS7-100)
(NASA CR-50627; JPL-TR-32-406)

The quasi-static magnetic characteristics of thin Permalloy films have been investigated using a sensitive automatic magnetic torque balance. The most striking feature of the many films investigated in the thickness range below 250 Å is their similarity to thicker films. The data for K are essentially constant until about 80 Å, where it drops quickly and smoothly to zero at about 30 Å. The value of the magnetization as a function of thickness supports that of Seavey and Tannenwald, obtained from microwave resonance absorption. The value of the longitudinal coercive force as a function of thickness exhibited a spread of values typical of thicker films of this particular fabrication procedure. Slight dependence on thickness could be observed in general agreement with the data of Behrndt.
Author

N63-18627 Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.
SOLID SOLUBILITY LIMITS OF Y AND Sc IN THE ELEMENTS W, Ta, Mo, Nb, AND Cr [Final Report, June 1, 1961-Nov. 30, 1962]
A. Taylor Wright-Patterson AFB, Ohio, Directorate of Materials, and Processes May 1963 42 p 5 refs
(Contract AF 30(616)-8315)
(ASD-TDR-63-204)

Alloys and diffusion couples of yttrium and scandium, with the refractory elements Nb and Ta of Group V, and Cr, Mo, and W of Group VI, have been examined by means of the optical microscope, X-ray diffraction, and mass spectrometry. The results indicate that the solid solubility of Y and Sc in these elements is less than 1 part per million. This is in conformity with the Hume–Rothery Rule that only a very restricted range of solid solution can be expected when the atomic diameter of solvent and solute differ by more than 14 to 15 percent.
Author

N63-18631 Defense Metals Information Center. Battelle Memorial Inst., Columbus, Ohio
SOME OBSERVATIONS ON THE ARC MELTING OF TUNGSTEN
J. L. Ratliff and H. R. Ogden May 31, 1963 17 p 9 refs
(DMIC-MEMO-168)

A semiempirical approach was employed with the aid of a statistical index of correlation to develop an "adjusted melting-rate parameter" which was linearly related to, and showed a

high degree of correlation with input power during melting. Melting data for tungsten-base materials ranging in composition from 92- to 100-percent tungsten were used in this analysis. The new parameter developed was a function of the five variables considered most important to the consumable-electrode arc-melting process, i.e., input power, melting rate, electrode density, and the ingot and electrode diameters. The linear relationship achieved from this analysis is given as follows: $P = 10\,R\rho(0.8D_e^2 + 0.2D_i^2) + 100$, or $R = \frac{P - 100}{10\rho(0.8D_e^2 + 0.2D_i^2)}$

Author

N63-18637 General Electric Co. Research Lab., Schenectady, N.Y.

RESEARCH AND DEVELOPMENT ON THE EFFECTS OF HIGH PRESSURE ON VARIOUS ELEMENTS AND BINARY ALLOYS. PART II: THE EFFECT OF PRESSURE ON TRANSFORMATION IN IRON ALLOYS [Final Report, Apr. 1, 1961-Apr. 1, 1962]

W. F. Claussen Wright-Patterson AFB, Ohio, AF Materials Lab., May 1963 38 p 7 refs

(Contract AF 33(616)-8206)

(ASD-TDR-62-479, Pt. II)

Pressure-temperature curves for the α-γ transformation in iron and iron alloys of Al, Cr, Mn, Co, and Ni were developed by duplex differential thermal-conductivity analysis. Similarly, eutectoid curves for Fe-C and Fe-Mn-C were developed. Special kinetic analysis of the data was necessary to assure closeness to equilibrium conditions for the eutectoid reactions, and good agreement with atmospheric data is recorded. Hystereses in the α-γ transformation generally increased with pressure.

Author

N63-18684 Hanford Atomic Products Operation, Richland, Wash.

METALLURGY RESEARCH OPERATION [Second] Quarterly Progress Report, Jan.-Mar. 1963

J. J. Caldwell, J. C. Tobin, T. K. Bierlein, R. L. Dillon, and R. G. Wheeler June 20, 1963 250 p refs

(Contract AT(45-1)-1350)

(HW-77052) OTS: $3.50

Progress in chemical and physical metallurgy research, reactor metal research, and materials engineering is reported. Discussed are: (1) neutron damage to metals, (2) swelling of irradiated fissionable materials, (3) plutonium physical metallurgy, (4) in-reactor measurements of mechanical properties, (5) irradiation effect on mechanical properties, (6) flux monitoring studies, (7) damage mechanisms, (8) environmental effects on chemcical metallurgy, (9) PRTR materials development, (10) aluminum corrosion and alloy development, (11) production reactor corrosion and coating, (12) N-reactor corrosion and hydriding studies, (13) radiation damage to reactor components, (14) gas loop development, (15) PRTR pressure tubes; and (16) N-reactor pressure tubes. N.E.A.

N63-18719 Rolla Metallurgical Research Center, Bureau of Mines, Mo.

RADIOTRACER STUDIES OF CERIUM AND SULFUR DISTRIBUTION IN STEEL

A. A. Cochran and V. R. Miller 1963 25 p 12 refs

(BM-RI-6256)

The objective of the research was to determine the final distribution of cerium additions to steel, their effect on sulfide inclusions, and the usefulness of radiotracer methods in investigating steel problems. Fifty-gram heats of steel were prepared that contained either cerium 141 and nonradioactive sulfur, or sulfur 35 and nonradioactive cerium. These steels were studied by autoradiography, measurements of their surface radioactivities, optical microscopy, and chemical analysis. Samples of the crucibles were analyzed quantitatively for cerium or sulfur by radioactivity counting methods. The addition of cerium to steel melts reduced the size and number of iron sulfide inclusions in the resulting steel. A significant fraction of the sulfur and most of the cerium penetrated into the MgO crucible during the melting operation. The cerium inclusions in steel were identified as cerium sulfide. Radiotracer methods were found to be versatile and highly sensitive.

Author

N63-18773 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

A METHOD FOR PREDICTING THE STATIC STRENGTH OF A STIFFENED SHEET CONTAINING A SHARP CENTRAL NOTCH

Herbert A. Leybold Washington, NASA, Aug. 1963 24 p 8 refs

(NASA TN D-1943) OTS: $0.75

The structural configurations treated consist of a thin sheet with a notch, and a stiffener centrally located over the notch. Residual static strengths are predicted for three structural configurations having ratios of notch area to stiffener area equal to 0.2, 1.0, and 5.0. Two aluminum alloys, 2024-T3 and 7075-T6, were investigated. The predicted results are compared with a limited number of experimental results, and fair agreement is obtained. Author

19 MATERIALS, NONMETALLIC

Includes: mechanical and physical properties of non-metals (e.g., plastics).

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 18 Materials, Metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-18379 College of Aeronautics, Cranfield (Gt. Brit.)

CHARACTERISTICS OF THE HIGH TEMPERATURE MECHANISMS OF CREEP AND RECOVERY IN GRAPHITE Quarterly Technical Status Report No. 3, Feb. 1-Apr. 30, 1963

[1963] 9 p

(Contract DA-91-591-EUC-2629)

(CoA-N-151, Pt. 3)

Progress has been made in establishing the creep and recovery characteristics, over the temperature range 2000° to 2750° C, for commercial graphite Morgan's EY9 and its ungraphitized form CY9. For ooth materials, the torsional stress to produce a given strain decreases with increasing temperature, except for EY9 above 2600° C. While the curves for CY9 and EY9 are markedly different at 2000° C, they become similar at 2500° C and 2400° C. The creep rate increases with increasing temperature and stress. For both EY9 and CY9, an increase in the creep temperatures results in a decrease in the proportion of strain recoverable in a given time. For EY9, as the amount of strain is increased, the proportion of strain recoverable in a given time decreases. All specimens are being examined for changes in microstructure after creep. Some changes have been noted in CY9; however, this work is still in progress. N.E.A.

N63-18634 Materials Research Corp., Orangeburg, N.Y.

THE ROLE OF THE GRAIN BOUNDARY IN THE DEFORMATION OF CERAMIC MATERIALS [Interim Report, Jan. 1962-Jan 1963]

G. T. Murray and A. J. Mountvala Wright-Patterson AFB, Ohio. Directorate of Materials and Processes. Mar. 1963 30 p 9 refs
(Contract AF 33(616)-7961)
(ASD-TDR-62-225, Pt. II)

The mechanical behavior of MgO grain boundaries at elevated temperatures was investigated. The shear strength of bicrystal specimens was obtained (constant loading rate tests) at 1400° C for a wide range of crystal misorientations. Large twist, low tilt boundaries fractured at extremely low stress (~ 150 g/mm^2) compared to other misorientations. For a given tilt angle, the fracture stress decreased with increasing twist component; the decrease being sharper for low ($\leq 20°$) tilt boundaries and more gradual for boundaries possessing large tilt components. The effect of temperature on the grain-boundary fracture stress was investigated for varying misorientations in the range 1200° to 1500° C. For each type of boundary orientation there was a characteristic temperature where there was a sudden drop in strength, this transition temperature being lowest for boundaries with a high twist component. Experiments on tricrystals indicated that the weaker twist-type boundaries controlled the fracture strength of the entire body.

Author

N63-18650 Boeing Co., Seattle, Wash.
EVALUATION OF Cb-752 COLUMBIUM ALLOY (Cb-10%W-2.5%Zr)
R. G. Baggerly Mar. 22, 1963 54 p 5 refs
(D2-35105)

An evaluation of Haynes–Stellite Cb-752 columbium alloy (Cb-10W-2.5Zr) has been conducted to establish its potential as a structural material for reentry vehicles. Properties which were investigated include tensile properties to 3000° F, creep properties to 3000° F, formability, ductile–brittle transition temperature, fusion welding, protective coating, oxidation, resistance, and emittance. Testing was conducted on 0.010-in. to 0.035-in. sheet from three heats of material. The evaluation indicates Cb-752 alloy has potentially useful strength in the temperature range of 2000° to 3000° F. The alloy displayed good formability at room temperature, sub-zero transition temperature, and good fusion weld strength and ductility. Principal problem areas disclosed were inadequate coating thickness with current Disil coating process and the brittle behavior of Disil coated welds. It is concluded that Cb-752 alloy is a promising high-strength, second-generation columbium alloy with potential advantages for structures of current and future reentry vehicles. It is recommended that riveted structures rather than welded structures should be considered for Cb-752 alloy due to the low-temperature brittleness of coated fusion welds.

Author

N63-18659 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN EXPERIMENTAL EVALUATION OF THREE TYPES OF THERMAL PROTECTION MATERIALS AT MODERATE HEATING RATES AND HIGH TOTAL HEAT LOADS
Andrew J. Chapman Washington, NASA, July 1963 22 p 8 refs
(NASA TN D-1814) OTS: $0.75

Three types of materials have been tested in an electric-arc-heated airstream to compare their performances as thermal-protection systems for reentry applications, involving long heating periods and high total-heat loads. Test-stream conditions and the specimen configuration were held constant for all tests. The quantity of heat dissipated by a specimen while its back-surface temperature was limited to a given value was used as a criterion for evaluating the materials. The tests indicated that charring composite materials were more effective than porous ceramic materials with an ablative filling or than low-temperature ablating materials.

Author

N63-18675 Engelhard Industries, Inc. Amersil Quartz Div., Hillside, N.J.
QUARTZ SPIRAL DELAY LINE Final Technical Report
H. Mack Thaxton Sept. 1962 152 p 4 refs
(Contract AF 30(602)-2438)
(RADC-TDR-62-553)

Research, designed to discover the feasibility of ultrasonic propagation in quartz media, is reported. The purpose of the research was (1) to determine the feasibility of bending optical quartz rod into various geometric forms for maximum delay time and minimum space requirements; (2) to determine the feasibility of direct propagation of Rayleigh and shear waves in the geometric form of the media studied, and the practical requirements for propagation; (3) to develop methods for obtaining specified characteristics in the transmitted and received wave form or pulse; and (4) to determine the feasibility of productively manufacturing the specific geometric form of quartz rod determined by the research. Laboratory models of a 6500-microsecond quartz-spiral delay line and a 1600-microsecond quartz-spiral delay line are produced.

N.E.A.

N63-18728 General Electric Co. Valley Forge Space Technology Center, King of Prussia, Pa.
THE BEHAVIOUR OF PLASTIC MATERIALS IN THE SPACE ENVIRONMENTS
A. F. Ringwood Mar. 11, 1963 23 p 15 refs
(Rept. 63SD243)

Space consists of a number of environments, of which several are rather easily simulated on earth by artificial means. These environments are vacuum, thermal-vacuum, ultraviolet, and particle radiation. Since space vehicles depend on the functioning of electronic equipment for the fulfillment of their missions, the effects of the space environments on the electrical properties of insulating materials are treated separately. The effects of the environments on some properties of plastic materials, both thermosetting and thermoplastic, are discussed.

Author

20 MATHEMATICS

Includes: calculation methods and theory; computers; data processing; and numerical analysis.

For related information see: 08 Communications; 09 Electronics; 10 Facilities; and 22 Navigation and Guidance.

N63-18230 European Atomic Energy Community, Brussels (Belgium)
RESEARCH ON THE BEST APPROXIMATION FOR EVALUATING A GIVEN FUNCTION. POLYNOMIAL APPROXIMATION IN TCHEBYCHEFF'S MEANING, ASYMPTOTIC DEVELOPMENT AND APPLICATION OF BESSEL'S FUNCTIONS
R. F. Gloden Joint Nuclear Res. Center, Ispra Estab. (Italy), Sci. Data Process. Center—CETIS, May 1963 39 p 10 refs In FRENCH; ENGLISH abstract
(EUR-282.f) Available from Belgian American Bank and Trust Co., N.Y., Account No. 121.86: 60 Belg. Fr.

The principal of approximation in the sense of Tchebycheff is used. The "critical point" notion is introduced that applied for even and odd functions. The Taylor expansions can be

used as a substitute for polynomials, the time of computation by an electronic computer being very short. The Hornecker methods are examined: correction of "critical point" abscissae; determination of the best approximation polynomial, for instance, by means of the resolution of a linear system. A short summary is given on Bessel functions and asymptotic expansions. The processes indicated by Hornecker have been programed. In the first programs, in simple precision, the error reached 10^{-7}; the next programs were written in double precision and allowed us to obtain the precision 10^{-12}. We have treated eight Bessel functions by means of a double-precision program. Author

N63-18245 Argonne National Lab., Ill.
1559/RE: A CODE TO COMPUTE RESONANCE INTEGRALS IN MIXTURES
Charles N. Kelber May 1963 22 p 7 refs
(Contract W-31-109-eng-38)
(ANL-6709)

1559/RE is an experimental IBM-704 code in FORTRAN language to compute the resonance integrals of isotopes in mixtures in the presence of hydrogenic moderation. There may be up to four isotopes, each with no more than 75 resolved resonance levels. Doppler broadening and interference scattering are included. No estimate is made of contributions from unresolved resonances. Typical running times are 30 min (with no Doppler broadening) to 90 min (with Doppler broadening) for problems involving 67 levels and unit lethargy widths. Author

N63-18260 Naval Ordnance Lab., White Oak, Md.
A COMPARISON OF NUMERICAL SCHEMES TO CALCULATE THE SOLUTIONS OF A NON-LINEAR PARTIAL DIFFERENTIAL EQUATION WITH SHOCKS
A Douglis Apr. 8, 1963 33 p 6 refs
(Math. Dept. Rept. M-33; NOLTR-63-8)

In a simple problem with shocks and rarefactions for the equation

$$u_t + (1/2\, u^2 + u)_x = 0\,,$$

six alternative calculation procedures have been tested as to cost and accuracy. Best results were given by the least elaborate method with the finest mesh, and by the most elaborate method with the coarsest mesh. Author

N63-18274 Florida U. Engineering and Industrial Experiment Station, Gainesville
ASYMPTOTIC ERROR CODING FOR THE BINARY SYMMETRIC CHANNEL WITH FEEDBACK Scientific Report No. 1
Edward J. Weldon, Jr. Apr. 1, 1963 129 p 10 refs
(Contract AF 19(628)-431)
(AFCRL-63-122)

Various asymptotic upper and lower bounds are calculated for linear (parity check) codes used with the Binary Symmetric Channel (BSC) with feedback. The feedback channel is taken to be noiseless and capable of instantaneous transmission. Two types of feedback are considered: (1) decision feedback, in which case one bit is fed back for each word transmitted in the forward channel, and (2) information feedback, in which case each received binary digit is fed back to the transmitter. The bounds calculated herein indicate that the best variable-length code has a higher probability of erroneous decoding than the best fixed-length code in which the feedback is used to vary the number of information symbols per word. They also indicate that the best code used without feedback has a higher probability of erroneous decoding than the best code used with decision feedback, which, in turn, has a higher probability of erroneous decoding than the best code used with information feedback. Author

N63-18315 Case Inst. of Tech. Engineering Design Center, Cleveland, Ohio
METHODS OF WAFFLE PLATE SYNTHESIS
Lucien A. Schmit, Jr., and William M. Morrow, II June 1963 81 p 8 refs
(NASA Grant NsG-110-61)

In general, the structural synthesis problem is, given a set of load conditions and side conditions for a structure, to find by systematic means, a structure which will support the loads, satisfy the side constraints, and maximize the merit by which the structure is to be evaluated. The structure dealt with is an integrally stiffened waffle-like plate. Six design parameters are employed; these are total depth, thickness of the sheet, stiffener spacing in two directions, and stiffener width in two directions. Several attempted methods of synthesis are discussed. Data are presented for five design problems. Author

N63-18331 Argonne National Lab., Ill.
FORTRAN PROGRAMS FOR COMPUTING ANGULAR DISTRIBUTIONS AND Q VALUES OF NUCLEAR REACTIONS
H. W. Broek May 2, 1963 44 p 4 refs
(Contract W-31-109-eng-38)
(ANL-6718)

Three FORTRAN programs, written for the IBM-704 computer, process the data from multichannel pulse-height analyzers in order to derive the Q values and differential cross sections of the groups observed. The standard deviations of the derived Q values and of the differential cross sections are also computed. With another program which has been written, the effects of impurities can be subtracted from pulse-height spectra observed when a target contains a mixture of nuclides. A fifth program computes the center-of-mass transformation quantities by means of the exact relativistic equations. Author

N63-18344 Naval Ordnance Lab., White Oak, Md.
A COMPUTER ANALYSIS OF TWO-STAGE HYPERVELOCITY MODEL LAUNCHERS
R. Piacesi, D. F. Gates, and A. E. Seigel Feb. 20, 1963 27 p 8 refs
(NOLTR-62-87; Ballistics Res. Rept. 67)

A computer study for predicting high-speed launcher performance was conducted using a one-dimensional hydrodynamics computer code. This computer code uses the Lagrangian scheme, and is based on the "q" method as devised by Von Neumann and Richtmyer. These calculations provide understanding for the proper variation of the launcher parameters for optimization of launcher performance. A series of calculations for the 2-in. Two-Stage Hypervelocity Model Launcher, which is in use in the NOL 1,000-ft. Hyperballistics Range No. 4, are presented and are compared with the actual performance of the launcher. Author

N63-18364 Stanford U. Applied Mathematics and Statistics Labs., Calif.
PRODUCTION PLANNING WITH CONVEX COSTS: A PARAMETIC STUDY
Arthur F. Veinott, Jr. May 22, 1963 41 p 9 refs
(Contract Nonr-225(53))
(Tech. Rept. 66)

Effects of changes in the requirements and capacity limitations (production, storage, backlog) upon optimal production levels are determined. The optimal production level in a given

period is a nondecreasing function of (1) the requirements in any period, (2) the upper and lower production capacity limits in the given period, and (3) the upper and lower storage limits in the given and all succeeding periods; the optimal production level in a given period is a nonincreasing function of (1) the upper and lower production capacity limits in any other period and (2) the upper and lower storage limits in all preceding periods. P.V.E.

N63-18403 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ASTRORELATIVITY
Helmut G. L. Krause May 22, 1962 64 p 28 refs
(NASA TM X-50080; MTP-P&VE-F-62-4) OTS: $6.60 ph, $2.12 mf

The special theory of relativity is extended to include the vectorial and scalar transformations of kinematical and dynamical quantities associated with bodies whose proper or rest mass is variable with time (i.e. rockets). Besides the known transformation formulas for force (or momentum flow rate), the general transformation formulas for power (or total energy flow rate) are given for the first time. All textbooks on the theory of relativity introduce the classical definition for the power which is an overspecification. It would be correct only when the rest mass is not changeable with time. This assumption is always fulfilled when applying the theory of special relativity to fast moving electrons, atoms, or nuclear particles, but it is not true for fast moving rockets. Generalized relativistic conservation laws of momentum and total energy (mass) are derived. Author

N63-18421 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STAR CATALOGS ON PUNCHED CARDS AND MAGNETIC TAPES — DETAILS
J. H. Berbert and J. D. Oosterhout June 1962 13 p 2 refs
(NASA TM X-50148; NASA X-520-62-86) OTS: $1.60 ph, $0.80 mf

Information combined from the AGK_2, the Yale Zone, and the Cape Photographic Star Catalog is available on punched cards and on magnetic tape. Coverage of and applications for this combined catalog are discussed. The star catalog, on punched cards, blankets the sky from the north pole to −64° declination. Magnitudes covered by the approximately 300,000 stars of the punched card catalog range from 5 to 11. Brighter stars appear but are omitted, presumably because their photographic images were too large for accurate measurements. Author

N63-18426 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
TECHNIQUES OF SIMPLIFICATION Final [Report]
David Luckham and Thomas Marill Mar. 29, 1963 48 p 10 refs
(Contract AF 19(604)-7290)
(AFCRL-63-112; Rept. 1006)

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APPENDIX 1. COMPUTATIONAL CHAINS AND THE SIMPLIFICATION OF COMPUTER PROGRAMS T. Marill p 14–22 3 refs (See N63-18428 17-20)
APPENDIX 2. ON THE EQUIVALENCE PROBLEM FOR FORMALIZED COMPUTER PROGRAMS D. Luckham p 23–43 2 refs (See N63-18429 17-20)

N63-18427 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
INTRODUCTION
In its Techniques of Simplification Mar. 29, 1963 p 1–13 5 refs (See N63-18426 17-20)

Techniques for completely simplifying computational chains have been found and published. These methods have been successfully programed. Extensions of these techniques which will simplify one-loop programs (not only reducing the number of instructions and storage locations, but also shortening the loop) have been developed. A necessary and sufficient condition for the equivalence of programs in the formal language is given. Author

N63-18428 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
COMPUTATIONAL CHAINS AND THE SIMPLIFICATION OF COMPUTER PROGRAMS
Thomas Marill *In its* Techniques of Simplification Mar. 29, 1963 p 14–22 3 refs Repr. from IRE Trans. on Electronic Computers, v. EC-11, no. 2, Apr. 1962 p 174–180 (See N63-18426 17-20)
(Contract AF 19(604)-7290)

In the synthesis of switching circuits, a formal representation of the function to be realized by the circuit is first established and simplified as much as possible. The simplification of a certain type of elementary program, containing no branching or internal modification, is considered in detail. It is argued that the analysis of this type of program, whose formalization is called a "computational chain," is a prerequisite to the analysis of more general programs. A system of notation is developed, and rules are given for minimizing the temporary storage requirements associated with a computational chain, for eliminating vacuous and redundant parts, and for forming combinations of chains. Author

N63-18429 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
ON THE EQUIVALENCE PROBLEM FOR FORMALIZED COMPUTER PROGRAMS
David Luckham *In its* Techniques of Simplification Mar. 29, 1963 p 23–43 2 refs (See N63-18426 17-20)

In this paper, an abstract programing language is developed in which programs with an infinite number of possible execution sequences may be represented. The problems of equivalence and simplification of programs in the language are discussed, and a necessary and sufficient condition for the equivalence of programs is found. Author

N63-18544 Los Alamos Scientific Lab., N. Mex.
STRUCTURE AND STABILITY OF THE SQUARE-WAVE DETONATION
J. J. Erpenbeck *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 442–453 15 refs (See N63-18501 17-26)
(Supported by AEC)

The structure of the square-wave limit of steady detonation is derived through the limiting behavior of a one-reaction detonation, having an Arrhenius rate constant, as the activation energy becomes large. In addition to the induction-zone and equilibrium-zone solutions, expressions are obtained to describe the reaction zone through which the chemical reaction proceeds. The hydrodynamic stability of the square-wave detonation is also considered, with particular attention to the mode of propagation of disturbances through the induction zone. The recent analysis by Zaidel of the stability of the square-wave model (in which the reaction zone is taken to be a front of

discontinuity) is found to be invalid in the sense that the reactivity of the fluid in the induction zone cannot be ignored for disturbances of a frequency commensurate with the length of this zone. An additional difficulty, arising from the use of Rankine–Hugoniot conditions across the reaction front, is also pointed out. It is shown that the initial-value problem for the two-front stability equations has no solution of exponential order in the time. Although no attempt is made to decide upon whether the two-front stability problem is reasonable (in the sense of having a solution), the normal-modes (or Laplace time transform) approach is not valid. It is believed that a more direct approach to the problem, whereby attention is focused at the outset onto the structure of the reaction "front," avoids both of these difficulties. Author

N63-18697 North Carolina U. Computation Center, Chapel Hill
PROPOSED STUDIES IN THE FIELD OF MULTIVARIATE APPROXIMATIONS
James W. Hanson and Richard J. Painter *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 251–254 1 ref (See N63-18688 17-29)

A proposed study of the numerical properties of functions of more than one independent variable is outlined. Author

N63-18698 North Carolina U. Computation Center, Chapel Hill
LINEAR PROGRAMMING APPLIED TO GUIDANCE FUNCTION FITTING
Sylvia M. Hubbard and Shigemichi Suzuki *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 255–260 2 refs (See N63-18688 17-29)

The application of linear programing to the approximation of the guidance functions in the Adaptive Guidance Mode is considered. Author

N63-18699 Northeast Louisiana State Coll., Monroe
EXISTENCE OF MULTIVARIABLE LEAST SQUARES APPROXIMATING POLYNOMIALS
Daniel E. Dupree *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 261–272 (See N63-18688 17-29)

Sufficiency conditions for the existence of multivariable least-squares approximating functions are developed. Author

N63-18700 North Carolina U. Computation Center, Chapel Hill
ANALYTIC DIFFERENTIATION BY COMPUTER APPLIED TO THE "FLAT EARTH" PROBLEM
James W. Hanson *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 273–276 2 refs (See N63-18688 17-29)

The application of analytic differentiation by computer, as applied to a simplified flat-earth calculus of variations problem, is described. Author

N63-18724 Pennsylvania U., Philadelphia
TOPOLOGICAL TRANSFORMATION GROUPS. COMPACT GROUPS IN E^n Interim Technical Report No. 2
E. H. Connell, D. Montgomery, and C. T. Yang [1963] 13 p 10 refs
(Grant DA-ARO(D)-31-124-G177)
(AROD-2056-13)

It is known that any compact group can act differentiably on E^n or S^n, for n large, in a manner which is topologically distinct from an orthogonal action of the group. On the other hand, there are some known cases where the action is always topologically equivalent to an orthogonal action; the purpose of this paper is to obtain further information in this direction. The principal result is the following. Theorem B (Main Theorem). Let G be a compact group which acts differentiably on $X = E^n$ with a fixed point set $F = F(G)$ which is assumed to be diffeomorphic to E^k, $k \leqq n-3$, and with all other orbits of the same type and of dimension r. Then the action of G is differentiably equivalent to a linear action of G on $X = E^n$ if $n - r \geqq 5$. Author

21 METEOROLOGY

Includes: climatology; weather forecasting; lower atmosphere studies; and oceanography.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

N63-18220 Nagoya U. Research Inst. of Atmospherics (Japan)
PROCEEDINGS OF THE RESEARCH INSTITUTE OF ATMOSPHERICS, NAGOYA UNIVERSITY, VOLUME 10
A. Kimpara, H. Ishikawa, K. Sao, and H. Tanaka, eds. Jan. 1963 43 p 22 refs

CONTENTS:

1. ATMOSPHERICS RADIATION FROM LIGHTNING DISCHARGES M. Takagi and T. Takeuti p 1–11 6 refs (See N63-18221 17-21)

2. CALCULATED STATISTICAL CHARACTERISTICS OF ATMOSPHERIC RADIO NOISE T. Nakai p 13-24 2 refs (See N63-18222 17-08)

3. A HIGH-RESOLUTION INTERFEROMETER FOR POLARIZATION MEASUREMENTS AT 9.4 Gc/s T. Kakinuma and H. Tanaka p 25–33 13 refs (See N63-18223 17-15)

4. MOSHIRI OBSERVATORY IN HOKKAIDO A. Iwai p 35–36 (See N63-18224 17-10)

5. DAYTIME ATTENUATION COEFFICIENT OF VLF WAVES DEDUCED FROM THE ELECTRIC FIELD INTENSITY OF ATMOSPHERICS K. Sao and J. Nakajima p 37–42 1 ref (See N63-18825 17-21)

N63-18221 Nagoya U. Research Inst. of Atmospherics (Japan)
ATMOSPHERICS RADIATION FROM LIGHTNING DISCHARGES
Masumi Takagi and Tosio Takeuti *In its* Proc. of the Res. Inst. of Atmospherics, Nagoya U., Vol. 10 Jan. 1963 p 1–11 6 refs (See N63-18220 17-21)

To see the mechanism of radiation from a lightning flash, we observed atmospherics in the frequency range of 0.1 to 500 mc/s under thunderstorm conditions. Within the distance of 30 km from the origins, the intensity of atmospherics from a discharge is of the order of 0.1 v/m at 100 kc/s in case of bandwidth 10 kc/s. With the increase of receiving frequency, the intensity decreases roughly in inverse proportion to the frequency, but in the range higher than about 3 mc/s, it seems to decrease more rapidly and show comparatively larger fluctuations than in the lower range. The radiation from a discharge is usually composed of many intermittent pulses individually

associated with electrostatic pulses, though it sometimes includes some long radiations such as continuing over 0.1 s, especially in the close vicinity of origins. The first leader of a ground discharge is one of the most powerful radiation origins in any frequency, but the return process does not always show a large intensity in the range higher than 10 mc/s. Author

N63-18225 Nagoya U. Research Inst. of Atmospherics (Japan)
DAYTIME ATTENUATION COEFFICIENT OF VLF WAVES DEDUCED FROM THE ELECTRIC FIELD INTENSITY OF ATMOSPHERICS
Kazuo Sao and Jun Nakajima *In its* Proc. of the Res. Inst. of Atmospherics, Nagoya U., Vol. 10 Jan. 1963 p 37–42 1 ref (See N63-18220 17-21)

The attenuation coefficient of VLF radio waves may be estimated approximately from the electric field intensity of atmospherics. The received atmospherics are applied simultaneously to three narrow band receivers tuned at respective frequencies, and their amplified and integrated output voltage are automatically recorded with recording ammeters. The difference of attenuation for respective frequencies can be estimated, provided that the distance to the origin of the emissions is known. Attenuation coefficients for 21 kc/s and 27 kc/s are estimated on the basis of an attenuation coefficient of 3 dB/1000 km for 10 kc/s. Because of the difficulty of estimating the distances to the origins, the results obtained are not always of high validity. P.V.E.

N63-18277 National Severe Storms Project, Kansas City, Mo.
FIELD OPERATIONS OF THE NATIONAL SEVERE STORMS PROJECT IN SPRING 1962
L. D. Sanders Washington, Dept. of Commerce, Weather Bureau, May 1963 75 p 10 refs (NSSP-14)

The 1962 field operations of the National Severe Storm Project (NSSP) were carried out in Oklahoma during the period between April 23 to June 8. The project involved radar observations, special and serial rawinsonde observations, sferics data, aircraft data, surface network data, and Tiros photography. J.A.J.

N63-18279 Army Electronics Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, AEROBEE AC 3.149(AF-98)
Marjorie Mc Lardie Hoidale June 1963 35 p 2 refs (ERDA-30)

Meteorological data gathered for the launching of Aerobee AC 3.149 (AF-98) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18280 Army Electronics Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, AEROBEE AC 3.371 (AF-96)
Marjorie Mc Lardie Hoidale June 1963 53 p 2 refs (ERDA-32)

Meteorological data gathered for the launching of Aerobee AC 3.371 (AF-96) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18281 Army Electronics Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, AEROBEE NC 3.134 (NRL-75)
Marjorie Mc Lardie Hoidale June 1963 38 p 2 refs (ERDA-35)

Meteorological data gathered for the launching of Aerobee NC 3.134 (NRL-75) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18282 Army Electronics Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, NIKE-APACHE SR-009, SR-010, AND SR-011
Gordon L. Dunaway June 1963 81 p 1 ref (ERDA-36)

Meteorological data gathered for the launching of Nike-Apache SR-009, SR-010, and SR-011 are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18336 Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, AEROBEE AC 3.510 (AF-100)
Gordon L. Dunaway June 1963 39 p 2 refs (ERDA-40)

Meteorological data gathered for the launching of Aerobee AC 3.510 (AF-100) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18477 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INFRARED RADIATION MEASUREMENTS PERFORMED FROM EARTH SATELLITES
R. A. Hanel *In* Chicago U. Labs. for Applied Sciences, Ill. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 34–66 17 refs (See N63-18473 17-10)

This report reviews the meteorological satellite program beginning with the Vanguard II experiment, and including the IGY Vanguard Project, the heat-balance experiment of V. E. Suomi, Tiros I, II, III, IV. The Tiros experiments are to continue until their successor, Nimbus, which will be improved with respect to resolution and accuracy, is ready. The primary objective remains cloud cover. The problems envisaged in setting up Nimbus are discussed in light of the information gained from the Tiros experiments. Author

N63-18478 Chicago U., Ill.
REDUCTION AND INTERPRETATION OF METEOROLOGICAL SATELLITE DATA
T. Fujita *In* Chicago U. Labs. for Applied Sciences, Ill. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 67–81 (See N63-18473 17-10)

This paper is concerned with recent work in satellite meteorology. The importance of precise analysis of photographs in regard to interpretation of radiation data, obtained by scanning radiometers, is indicated with the aid of specific illustrations. The value of superimposition of cloud patterns on well-analyzed weather maps for purposes of meteorological interpretation by satellite photographs is also demonstrated. Radiation data obtained by Tiros is discussed. Author

N63-18479 Little (Arthur D.) Inc., San Francisco, Calif.
INFRARED REFLECTANCE PROPERTIES OF HIGH ALTITUDE CLOUDS
H. Blau, Jr. and E. C. Reifenstein III *In* Chicago U. Labs. for Applied Sciences, III. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 82–85 1 ref (See N63-18473 17-10)

The objective of the program is an experimental investigation of the infrared spectral reflectance properties of high-altitude clouds. Interest is confined to clouds protruding to altitudes above 30,000 feet, and ranging from large, dense cumulus systems to thin, broken cirrus. The equipment necessary for such a task is discussed in detail, and the types of information of immediate importance to the program are given some attention. Author

N63-18482 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio
PHOTOGRAPHIC CONTRAST ATTENUATION BY THE ATMOSPHERE
R. Sink *In* Chicago U. Labs. for Applied Sciences, III. Symp. on Background Radiation. Ultraviolet, Visible and Infrared Levels and Distributions [Spring 1962] Apr. 1963 p 103–107 (See N63-18473 17-10)

Our objective is to correlate atmospheric conditions of temperature, pressure, humidity, and other geophysical parameters with reduction of contrast in aerial photographs. This paper is a brief summary of these activities. Author

N63-18498 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
PROJECT FOG DROPS. INVESTIGATION OF WARM FOG PROPERTIES AND FOG MODIFICATION CONCEPTS 1st Quarterly Progress Report, 1 Feb. 1963–1 May 1963
James E. Jiusto [1963] 28 p 33 refs
(NASA Contract NASr-156)
(NASA CR-50530; CAL-RM-1788-P) OTS: $2.60 ph, $1.04 mf

Progress in investigations of warm fog properties and fog modification concepts is reported. The fog types that affect air terminals in the U.S. have been identified and grouped into three categories: radiation fog and advection fog, which constitute the so-called air mass fogs, and frontal fogs. Based on this classification and a literature review, physical fog models were devised for radiation fog and advection fog. A formulation was used in two sample cases to define the vertical distribution of fog liquid water as a function of ambient wet-bulb temperature and mixing ratio. An analysis was made of the effect of monolayers of fatty acids on fog droplet growth rates on the supposition that such layers might tend to enhance droplet growth, precipitation, and depletion of the fog water. The decrease in evaporation rate of water droplets coated with monolayers in a subsaturated environment has led to a fog-control concept. Laboratory test equipment was partially assembled for checking the droplet monolayer effects, as theorized, and the effect of other materials on droplet behavior. N.E.A.

N63-18657 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SOME ASPECTS OF STRATOSPHERIC CIRCULATION DERIVED FROM METEOROLOGICAL ROCKET FIRINGS OVER THE UNITED STATES DURING THE WINTER OF 1961
Mohammad Rahmatullah (Pakistan Meteorol. Dept.) Washington, NASA, July 1963 15 p 10 refs
(NASA TN D-1755) OTS: $0.50

Data from six rocket-launching sites in North America obtained from a series of meteorological-rocket firings conducted between January 16 and February 23, 1961, were analyzed. Time cross sections of winds at Wallops Island, Virginia, and Cape Canaveral, Florida, are presented and discussed in the light of synoptically signigicant situations as determined by the 10-mb chart. Temperature soundings in the lower stratosphere relevant to the typical situations are also considered. TIROS II radiation data for orbits 827 and 957 have been analyzed in order that the effect of ozone on stratospheric disturbances might be studied. It was found that the penetration of the mesospheric westerly jet to lower levels was associated with the formation of a marked trough of low pressure over the eastern United States, and coincided with the occurrence of a severe cold period. No final stratospheric warming was observed, and by mid-February the westerlies were back to full strength. A microstructure of the mesodecline at 63 km was observed at Wallops Island and at White Sands, New Mexico. The analysis of TIROS II radiation data pointed out that the effect of changes in the ozone layer is completely masked by the varying cloud pattern. Author

N63-18678 Deutscher Wetterdienst, Offenbach am Main (Germany)
CELL STRUCTURE OF THE ATMOSPHERE: ATTEMPT TO ESTABLISH AN ATMOSPHERIC MODEL OF THE NON-TROPICAL LATITUDES ON THE BASIS OF SIMPLE SUPPOSITIONS Final Report
Heinrich Faust and Walter Attmannspacher May 1962 65 p 46 refs
(Contract DA-91-591-EUC-1668-01-7330-61)

This meteorological review includes discussions of: (1) the derivation of the relative positions of significant meteorological levels (pleisto-layers); (2) the homopycnic layer and the Wagner–Linke layer; (3) the null layer; (4) the meridional gradients of air pressure, temperature, and density; (5) the layers of maximum meridional gradients of air temperature and air density above the null layer; (6) the influence of the vertical motion in the null layer on temperature and density fields; (7) the upper boundary of the ozone layer as a heating level; and (8) the joint meteorological effects of the earth's surface as a heating level and the upper boundary of the ozone layer as a heating level. I.v.L.

N63-18679 Deutscher Wetterdienst, Offenbach am Main (W. Germany)
CELL STRUCTURE OF THE ATMOSPHERE: THE CHANGE OF THE LARGE-SCALE CIRCULATION IN THE STRATOSPHERE Scientific Report No. 2
W. Attmannspacher and H. Faust Mar. 1963 18 p 27 refs (Contract DA-91-591-EUC-2174)

The occurrence of very persistent easterly winds in summer and westerly winds in winter at an altitude above approximately 20 km is discussed in the light of explaining the lack of relationship which seems to exist between this stratospheric circulation and the tropospheric circulation. Also discussed is how the change from the east–west circulation in summer to the west–east circulation in winter takes place. The separation between the two broadly independent circulations, the stratospheric and tropospheric-substratospheric circulations, comprehending the surface weather features, appears to be affected by the separation layer at about 20 km, which in winter is a layer of minimum winds (null layer of 2nd kind) and in summer a layer of zero values of the wind, associated with a shift from west to east (null layer of 3rd kind). I.v.L.

N63-18683 Air Force Cambridge Research Labs., Bedford, Mass.
JOINT INDO-UNITED STATES BALLOON FLIGHT PROGRAM – 1961

Charles W. Chagnon, ed. Dec. 1962 207 p refs
(Contract AT(49-7)-1431)
(AFCRL-62-1135)

The Joint Indo-U.S. Balloon Flight Program was conducted at Hyderabad, India, from February through April, 1961. A complete report of all phases of this international, cooperative effort is presented, including the details of the balloon-flight operations, the preliminary scientific results achieved, and an evaluation of the overall accomplishments of the program. In addition to the contribution of heretofore unavailable data on the equatorial stratosphere, the operational success of the program demonstrated the feasibility of performing recoverable high-altitude balloon flights in the tropical latitudes. Author

N63-18687 Army Electronic Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.

METEOROLOGICAL DATA REPORT, AEROBEE AS 1.310 (1.14NAS) AND AEROBEE AS 1.311 (1.13NAS)

Marjorie Mc Lardie Hoidale June 1963 60 p 2 refs
(ERDA-31)

Meteorological data gathered for the launching of Aerobees AS 1.310 (1.14NAS) and AS 1.311 (1.13NAS) are presented. The data appear, along with calculated ballistic data, in appendixes. Author

N63-18730 European Atomic Energy Community, Brussels (Belgium)

4TH METEOROLOGICAL ANNUAL REPORT [4° ANNUARIO METEOROLOGICO]

G. Bollini, I. Danese, C. Gandino, and G. Scaglianti Joint Nucl. Res. Center, Ispra Estab. (Italy), Protection Dept., May 1963 94 p In ITALIAN; ENGLISH abstract
(EUR-276.i) Available from Belgian American Bank and Trust Co., N.Y., account No. 121.86: 130 Belg. Fr.

A short description of atmospheric phenomena observed and climatological methods used, with emphasis of the salient features of the meteorological year 1962, is followed by 24 tables and 22 graphics, from which a comprehensive picture of the overall situation can be obtained. The second part publishes, for the first time, temperature gradients measured by electrical resistance thermometers from the meteorological tower, the top of which is 120 m high. A comparison of this data with seasonal temperature gradients between two screens on the hill and on the plain is also given. The hourly average wind velocity, obtained from two anemographs located at altitudes of 60 and 120 m on the tower, is used for wind profile parameter p calculations and classifications. Author

N63-18747 Deutscher Wetterdienst, Offenbach am Main (W. Germany)

A NEW METHOD OF EVALUATING WEATHER SITUATIONS IN A QUANTITATIVE-SYNOPTIC WAY WITH THE GEOPOTENTIAL HEIGHT BEING TAKEN AS VERTICAL COORDINATE. FIRST REPORT: THE THREE-DIMENSIONAL DISTRIBUTION OF AIR DENSITY AND MASS DIVERGENCE

Tenth Special Technical and Scientific Report

H.-U. Rogall and H. Faust Feb. 28, 1962 136 p 25 refs
(Contract DA-91-591-EUC-1668-01-7330-61)

Synoptic charts showing the aerological atmospheric conditions are presented for the two main synoptic observations on the 3rd December 1960. In contrast to the common procedures, they are constant height charts for 12 levels of geopotential between 1 and 20 gpkm. Comments are given on the advantages and disadvantages of the z-system used here and of the common p-system; their difference in meaning is discussed. The z-system allows for the meaningful investigation of air density in the three-dimensional field; therefore, significant differences between the density structure obtained with synoptic means and that obtained by Linke and Doporto for average conditions could be clarified. With the aid of the density change and by using the continuity equation, it is possible to obtain numerical values of the three-dimensional distribution of mass divergence without considering the wind structure. The discussion of the results is followed by a verification of the numerical values with the aid of the tendency equation. The essence of the results of this investigation is compared with v. Fricker's conception on the structure of primary and secondary waves. Author

N63-18768 Czechoslovak Academy of Sciences. Geophysical Inst., Prague

MEASUREMENT OF CONCENTRATIONS OF GIANT CONDENSATION SULPHATE NUCLEI IN THE LOWER LEVELS OF THE ATMOSPHERE

Josef Podzimek and Ivan Černoch (Meteorol. Lab.) *In its* Collection of Geophysical Works—1961 1962 p 475-493 23 refs In ENGLISH; CZECH and RUSSIAN summaries (See N63-18752 17-12)
(Paper No. 161)

Concentration measurements of giant sulfate condensation nuclei were made. These measurements are based on the Lisegang ring effect, i.e., a nucleus, which falls on a gelatin film sensitized by barium chloride, leaves a circular trace in it (Lisegang ring) of undissolved barium sulfate. Results of these measurements led to the following conclusions: (1) The measurements confirmed the applicability of the method of Lisegang rings to the measurement of giant sulfate condensation nuclei. (2) The total concentrations of giant sulfate nuclei are lower in all the levels measured (up to 2.5 km) than the concentration of giant chloride nuclei (measured in a previous study). (3) The concentration averages, determined from six plane ascents in Vrchlabi and sixteen ascents in the High Tatras, confirmed that the concentrations of giant sulfate nuclei in Vrchlabi are much higher than in the High Tatras. (4) A study of the size spectrum of sulfate nuclei showed interesting differences between the spectra from Vrchlabi and the High Tatras. In the first case, the spectra of the nuclei were wider. In the second case, the nuclei having radii greater than 2 μ occurred very rarely. In Vrchlabi, the size spectra of all nuclei in all levels were similar, and the connection between the concentration and the size of the nuclei is expressed quite well by the general relation derived by Nykiama and Tanasava. I.v.L.

22 NAVIGATION AND GUIDANCE

Includes: autopilots; star tracking; inertial platforms; and traffic control.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; 20 Mathematics; and 29 Space Sciences.

N63-18304 Illinois U. Coordinated Science Lab., Urbana

AUTOMATIC AIR TRAFFIC CONTROL. PART II—AN EXPERIMENTAL CONTROL LOGIC

L. S. Kypta and H. Bobotek Apr. 1963 125 p 1 ref
(Contract DA-36-039-TR-US-AMC-02208(E))
(R-146)

This report describes the experimental control logic and the results of the simulation. The simulation was done on the Cornfield System which consists of a special purpose tracking

computer (TASC) and a general purpose digital computer (ILLIAC) which are connected. The main assumptions in the work are (a) perfect tracking, (b) zero winds aloft, and (c) all traffic operating at the same altitude. Simulated traffic consists of four types of aircraft, ranging in cruising speed from 131 mph to 542 mph, and the assumed method of steering is vectoring via digital data link. The Cornfield System capacity of 25 aircraft is shown to have no relationship to the capacity of a system especially designed to execute automatic control. Author

N63-18463 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
TRAJECTORY ENTRY CONDITIONS AT THE LUNAR SPHERE OF INFLUENCE FOR APPLICATIONS TO DETAILED STUDIES OF NEAR-MOON TRAJECTORY AND IMPACT CONDITIONS
Harold A. Hamer and Ward F. Hodge Washington, NASA, July 1963 55 p 9 refs
(NASA TN D-1820) OTS: $1.50

Flight conditions at the lunar sphere of influence have been compiled for use in conjunction with detailed studies of earth–moon trajectories. The calculations were based on the assumption that the ascent portion of the trajectory is divided into two parts: one part from earth injection to entry into the sphere of influence (earth-departure trajectory) and the other part lying within this sphere (near-moon trajectory). Each part is approximated by two-body solutions. In the compilation, trajectory entry conditions at the lunar sphere of influence are presented in relation to earth-injection conditions, and essentially describe the complete family of earth-departure trajectories that pass into the sphere of influence. Extensive data pertaining to ballistic trajectories within the sphere of influence are also presented. Author

N63-18469 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A TRAJECTORY ANALYSIS OF A VARIABLE-DRAG PAYLOAD EJECTED FROM A VEHICLE IN A LOW EARTH ORBIT
Richard Reid and David B. Middleton Washington, NASA, July 1963 29 p 3 refs
(NASA TN D-1938) OTS: $0.75

Useful trajectories are determined for dispatching the payload to desired regions for space experimentation. Alteration of the basic trajectories is accomplished by means of the variable-drag feature. The drag effects are studied in terms of changing the ballistic number of the payload at predetermined points along the basic trajectories. The results of the study are presented as plots of distance and velocity relative to the orbiting vehicle. Particular emphasis is given to the determination of parameter combinations which lead to conditions favorable for using the payload as a target for rendezvous practice. The results of this study indicate that the scheme of ejecting a variable-drag payload from an orbiting vehicle can be developed into a useful method of space experimentation. The trajectories obtainable are limited only by the ejection velocity and weight-area ratio of the payload. Payload trajectories can be predetermined, within the accuracies of the parameters, for particular experiments by using the approach of this study. Author

N63-18633 Lockheed Missiles and Space Co., Sunnyvale, Calif.
GUIDANCE PHENOMENA FOR A MARS MISSION
John V. Breakwell, Lars F. Helgostam, and Martin A. Krop July 8, 1963 27 p 6 refs Presented at the AAS Symp. on the Exploration of Mars, Denver, June 1963

The principal guidance phenomena for a manned nonstop roundtrip to Mars are sought by geometric, mathematical, and physical examinations of the trajectory and its sensitivity to small perturbations. The two major findings are that (1) the deviations from the nominal trajectory in both the early and the final stages of the midcourse portions of each leg of the trip are fairly well described by uncoupled, straight-line motion, and (2) with reasonably good optical sighting accuracy, such as a standard deviation of 10 seconds of arc in optical sightings on the planets against the star background, the entire interplanetary midcourse navigation and guidance problem can be solved in the vicinity of the two terminal planets with a modest expenditure of corrective velocity. On most relatively short-duration interplanetary trips, it is advantageous to employ variable-time-of-arrival guidance procedures; on the relatively long ones, it is advisable to guide for fixed time of arrival early in the trip and variable, later. Guidance in the final phase of the midcourse appears to be amenable to fairly simple, straightforward methods based on observing only the magnitude and the direction of the angular rate of change of the line of sight to the target planet. Author

23 PHYSICS, GENERAL

Includes: acoustics; cryogenics; optics; and thermodynamics.
For astrophysics see: 05 Astronomy and Astrophysics.
For related information see: 12 Geophysics; 29 Space Sciences; 24 Physics, Plasma; and 24 Physics, Solid-State.

N63-18232 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
THEORETICAL ELASTIC STRESS DISTRIBUTIONS IN CASSINIAN DOMES
David A. Spera and Robert H. Johns Washington, NASA, July 1963 55 p 12 refs
(NASA TN D-1741) OTS: $1.50

The geometric properties and elastic stress distributions in a family of domes with constant thickness, temperature, internal pressure, and material properties are investigated, and results are presented in a form suitable for preliminary design. The governing differential equations are solved by a finite-difference technique, which is presented in detailed algebraic form for the shells investigated, and in matrix form for general shells of revolution. Meridians of the domes considered are modified curves of Cassini and contain two parameters that permit a wide range of shapes. Variations in dome curvature, height, area, and volume with these two parameters are calculated. Membrane stress distributions and significant bending stresses are given for a class of domes that close cylinders of equal thickness, and have zero curvature at the junction section. Complete stress distributions are found for several dome geometries. In addition, a dome was fabricated and tested, and good agreement between experimental and theoretical results was obtained. Author

N63-18238 International Commission on Acoustics
CONGRESS REPORT II [OF] THE FOURTH INTERNATIONAL CONGRESS ON ACOUSTICS, COPENHAGEN, AUGUST 21-28, 1962
Copenhagen, Organ. Comm. of the Fourth Intern. Cong. on Acoustics, [1963] 240 p refs
(Supported by UNESCO, Danish Govt. Fund for Sci. and Ind. Res., Thomas B. Thrige Found. et al)

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14. A DECADE OF MUSICAL ACOUSTICS R. W. Young (Navy Electronics Lab.) p 231–250 90 refs

N63-18240 Rochester U., N.Y.

MICROWAVE ULTRASONICS AND STUDIES OF THE SOLID STATE

E. H. Jacobsen *In* International Commission on Acoustics Congress Report II [of] the Fourth Intern. Cong. on Acoustics, Copenhagen, Aug. 21–28, 1962 p 115–138 29 refs (See N63-18238 17-23)

The highest lattice frequencies in solids lie between 10^{13} and 10^{14} cps, whereas the highest elastic wave frequency generated by laboratory methods falls some three orders of magnitude lower. Those areas which have received current attention such as, for example, phonon-phonon scattering, spin-phonon interaction, and traveling-wave amplification are still in an elementary stage. Electron-phonon interaction as related to electrical and thermal conductivity, and magnetoplasma phenomena have received little attention to date. There exists also the possibility of parametric interaction between spins and phonons for amplification, detection, and harmonic generation of elastic waves. These techniques in combination with the phonon maser principle, besides possessing interest in their own right, may provide coherent sources of thermal phonon radiation, and so make possible a detailed study of interatomic forces, energy transport, and a variety of collective excitations in complex systems. Author

N63-18241 Göttingen U. Physikalisches Inst. (W. Germany)

NEW ANALOGIES BETWEEN ACOUSTIC AND ELECTROMAGNETIC OSCILLATIONS AND WAVEFIELDS [NEUERE ANALOGIEN ZWISCHEN AKUSTISCHEN UND ELEKTROMAGNETISCHEN SCHWINGUNGEN UND WELLENFELDERN]

Erwin Meyer *In* International Commission on Acoustics Congress Report II [of] the Fourth Intern. Cong. on Acoustics, Copenhagen, Aug. 21–28, 1962 p 139–156 In GERMAN (See N63-18238 17-23)

This review of the analogies between acoustic and electromagnetic oscillations and wavefields covers: (1) the phenomena of sound propagation in a sound-damped wind tunnel with intermittent wall structure, under conditions of strong superimposed direct-current airflow, and the analogy between the phenomena of sound propagation under these conditions and under those existing in a microwave traveling field wind tunnel; (2) the development of electromagnetic reflection-free absorbers, analogous to various acoustic absorbers, for sound absorption parallel to an absorbing surface; and (3) the construction of a common reverberating chamber for both electromagnetic and acoustic waves. I.v.L.

N63-18242 National Physical Lab., Teddington (Gt. Brit.)

RECENT ADVANCES IN THE SUBJECTIVE MEASUREMENT OF NOISE

D. W. Robinson *In* International Commission on Acoustics Congress Report II [of] the Fourth Intern. Cong. on Acoustics, Copenhagen, Aug. 21–28, 1962 p 157–177 46 refs (See N63-18238 17-23)

The correlation that exists between certain qualities of the sound as perceived by a hearer and the physical properties of the same sound is reviewed. The rule relating noise loudness in sones (the scale in which the noise number is proportional to the average person's estimate of the magnitude of the loudness sensation) to the loudness level in the empirical phon scale is presented as a good, but not exact, measure of noise intensity. Zwicker's method of calculating the loudness of sounds of arbitrary spectra is discussed, and the simplified method is given as an approximation of the noise bands by multiples of 1/3 of an octave, making the formula adaptable to engineering use without affecting the calculations. The measurable qualities of noise and experimental methods of measuring noise are reviewed and the problems of subjective measurement are discussed. D.E.R.

N63-18243

SOME PHYSICAL PHENOMENA THAT ARISE IN HIGHLY INTENSIVE ULTRASOUND FIELDS [EINIGE PHYSIKALISCHE ERSCHEINUNGEN, DIE IN HOCHINTENSIVEN ULTRASCHALLFELDERN ENSTEHEN]

L. D. Rosenberg *In* International Commission on Acoustics Congress Report II [of] the Fourth Intern. Cong. on Acoustics, Copenhagen, Aug. 21–28, 1962 p 179–194 17 refs In GERMAN (See N63-18238 17-23)

Acoustic "boiling" in sound waves and ultrasonically induced cavitations are reviewed in the light of understanding the phenomena of aerosol "dusting" and the acoustically induced coagulation in liquids and gases. I.v.L.

N63-18244 Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
ROCKET NOISE OF LARGE SPACE VEHICLES
Francis M. Wiener *In* International Commission on Acoustics Congress Report II [of] the Fourth Intern. Cong. on Acoustics, Copenhagen, Aug. 21–28, 1962 p 209–230 55 refs (See N63-18238 17-23)

The exploration of space by man is predicated on the use of large rocket-propelled space vehicles. The rocket engines required for lifting the upper stages and space capsule from the earth's atmosphere generate sound powers of the order of 10^8 watts. To ensure success, the magnitude of the noise and vibration fields generated by the engines, and their effect on the vehicle and on personnel and structures on the ground must be considered. Since many static tests must be conducted with full thrust prior to launching, the effects of frequent exposure to rocket noise on the residents and buildings in communities many miles away must be assessed. This paper presents a review of the work on these problems carried out in the U.S.A. The results are given in terms of full-scale field data supplemented by data on scale models. Areas requiring future theoretical and experimental investigation are pointed out. Author

N63-18258 Laboratoire de Physique et Hautes Energies, Orsay (France)
CALCULATION OF THE K° PARAMETERS FROM NEARBY SINGULARITIES
B. Div, J. L. Gervais, and H. R. Rubinstein June 1963 28 p 19 refs
(Rept. 30)

A numerical attempt is made to calculate the K° mass and width from one-particle exchange forces. Due to the appearance of an extra parameter, a family of solutions is obtained, both in the one-channel (π + K) and the two-channel (π + K and η + K) cases. Though mass and width can be well reproduced, the generating coupling constants come much too large. This raises some objections to the "bootstrap" generation of particles, discussed in the conclusion. Author

N63-18271 Electric Boat Div., General Dynamics Corp., Groton, Conn.
SHELL MODE COUPLING Final Report, 1962
R. J. Mc Grattan and E. L. North Mar. 1963 43 p 6 refs
(Contract Nonr-3594(00))
(U411-63-005)

This report describes a parametric study of stiffened cones and cylinders to analytically determine the effects of a longitudinal steady-state driving force on the radial velocity of axially symmetric shells. The "lumped-mass" technique is utilized to predict the natural frequencies, mode shapes, and impedances (point and transfer) for eight cases. Although the natural frequencies are not too sensitive to changes in shell thickness and frame area, the transfer impedances (hence radial velocities) vary significantly for the cases studied. Author

N63-18272 Stanford Research Inst., Menlo Park, Calif.
COLLISION LIFETIMES IN MANY-BODY PROCESSES
Felix T. Smith [1962] 8 p refs Repr. from Phys. Rev., v. 130, no. 1, Apr. 1, 1963 p 394–401
(NASA Contract NASr-49(07); also supported by NSF)
(NASA CR-50450)

Collision lifetimes and the lifetime matrix are expressly formulated so as to include three-body and many-body collision and breakup processes. The many-body states are expressed in the generalized angular-momentum representation, in which the principal radial coordinate is proportional to the square root of the trace of the inertia tensor for the N-body configuration. The physical significance of the (energy-dependent) three-body collision lifetime $Q^{(3)}(E)$ is clarified by considering the special case where the three-body breakup occurs by way of a metastable two-body intermediate. If the metastable occurs with an internal energy E_m and a decay time τ_m, and the process creating it has a collision lifetime $Q^{(2)}(E-E_m)$, the connection with $Q^{(3)}$ is: $Q^{(3)}(E) = Q^{(2)}(E-Em) + \tau_m E_m/E$. This result holds both classically and quantally. Author

N63-18297 Bureau of Mines, Berkeley, Calif.
LOW-TEMPERATURE HEAT CAPACITY AND ENTROPY AT 298.15° K. OF SCANDIUM
W. W. Weller and K. K. Kelley 1962 7 p 2 refs
(BM-RI-5984)

Experimental heat-capacity data for scandium metal in the temperature range from 50° to 298° K is given, together with the entropy value at 298.15° K derived from these data through application of the third law of thermodynamics. The heat capacity data are given in tabulated form and are expressed in defined calories (1 cal. = 4.1840 abs. joules) per mole of scandium. The calculated entropy value at 298.15° K was 8.20 ±0.06 cal/deg mole. N.E.A.

N63-18321 Maryland U. Inst. for Molecular Physics, College Park
INTERACTION ENERGIES AND TRANSPORT COEFFICIENTS OF Li + H AND O + H GAS MIXTURES AT HIGH TEMPERATURES
Paul H. Krupenie (NBS; M. S. Thesis), Edward A. Mason, and Joseph T. Vanderslice June 17, 1963 42 p 48 refs
(NASA Grant NsG-5-59)
(NASA CR-50453; IMP-NASA-33) OTS: $4.60 ph, $1.48 mf

Accurate potential energy curves for the $X^1\Sigma_g^+$, $A^1\Sigma_u^+$, $B^1\Pi_u$, and $C^1\Pi_u$ states of the Li_2 molecule are calculated from observed spectroscopic data by the method of Rydberg–Klein-Rees (RKR), and compared with previous quantum-mechanical calculations. Long-range attractive potentials are estimated by extrapolation of functions fitted to the RKR ground-state curves of Li_2, LiH, and OH. From these, the repulsive potentials derivable from interacting ground-state atoms are estimated semiempirically. Collision integrals computed from the potentials, and transport coefficients of the gaseous systems Li + Li, Li + H, and O + H are calculated for temperatures of 1000° to 10,000° K. A surprising result is the extraordinarily large values of the collision integrals for Li + Li (and Li + H) interactions, which result in unexpectedly small values of diffusion coefficient, viscosity, and thermal conductivity. For traces of Li in Li + H mixtures at low temperature, the thermal diffusion factor is very large. Various approximate formulas for viscosity and thermal conductivity of mixtures are seen to give poor agreement with exact calculations for the systems considered. Author

N63-18351 Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.
FORT McCLELLAN RADIOLOGICAL INSTRUCTION AREA (ARMS-II)
R. B. Guillou June 26, 1963 14 p 2 refs
(Supported by AEC)
(CEX-62.6.2) OTS: $0.50

An Aerial Radiological Measuring Survey (ARMS) of the U.S. Army Chemical Corps School, Radiological Instrumentation Area, Fort McClellan, Ala., was made. The primary purpose of the survey was to test and evaluate the operation of the ARMS-II system over a high-intensity radiation field of small area. The radiation area is about 1000 yards long and less than 300 yards wide. The sources (Co^{60}) produce a dose rate

of about 300 mr/hr along the center line. Data from an areal survey of the range were contoured to show the distribution of the gamma-ray flux at 500 ft above the ground. The count rate over the center of the range was greater than 15,000 counts/sec on the low-sensitivity detector. Data on the air attenuation of gamma rays were collected from flights along the center line of the range at altitudes ranging from 100 to 3500 ft above the ground. Maximum count rates on low sensitivity ranged from more than 50,000 counts/sec at 100 ft to 1300 counts/sec at 1300 ft. Maximum count rates on high sensitivity ranged from more than 50,000 counts/sec at 1500 ft to about 2000 counts/sec at 3500 ft above the ground.

Author

N63-18367 National Bureau of Standards, Washington, D.C.
THE ABSROPTION SPECTRUM OF THE "PINK" AFTERGLOW OF NITROGEN IN THE VACUUM ULTRAVIOLET **Technical Report**
Arnold M. Bass June 14, 1963 26 p 23 refs Submitted for Publication
(NASA Order R-64)
(NASA CR-50485; NBS-8007) OTS: $2.60 ph, $0.98 mf

The absorption spectrum of the short-lived "pink" afterglow in nitrogen was photographed in the vacuum ultraviolet from 1600 to 1150 A. A large number of relatively intense absorption bands were observed. It is suggested that these may result from transitions between the ground state ($X^2\Sigma_g^+$) and several excited electronic states ($b^1\Pi_g$, $b'\ ^1\Sigma_u^+$, and others) in which ground-state vibrational levels of the ground electronic state are populated to very high levels (up to about $v'' = 20$). It appears that more than 10% of the nitrogen molecules are excited to vibrational levels greater than $v'' = 8$. Author

N63-18378 Rome Air Development Center. Electronic Warfare Lab., Griffiss AFB, N.Y.
ON FERROMAGNETIC RESONANCE
Bruno Beek and Richard Rawson May 1963 46 p 16 refs
(RADC-RAW-TM-63-6)

This report discusses gyromagnetic and ferromagnetic resonance experiments. The relationship of the spectroscopic splitting factor to the magnetomechanical ratio is derived using first-order perturbation theory. Power absorption in a metal-backed ferrite slab is theoretically determined, and plots for several slab thicknesses of angular frequency versus power absorbed are given. Author

N63-18408 Vermont U., Burlington
RADIOACTIVE TRACER AND WORK FUNCTION STUDY OF CHEMISORPTION OF GASES ON METALS **Semiannual Status Report No. 2**
A. D. Crowell May 1963 5 p
(NASA Grant NsG-241-62)
(OTS: $1.10 ph, $0.80 mf

Work on the ultrahigh vacuum system to be used in connection with the investigation of work function changes produced by chemisorption is continuing. The vacuum measuring and gas control system has been completed and the system has been tested for vacuum. The ionization gage can be used as a thermal gage of the Pirani type. Work on the photoadsorption chamber and the development of a low background counting arrangement is continuing. Work has commenced on the study of an appropriate optical system for focusing ultraviolet light from a grating monochromator onto the surface to be studied. N.E.A.

N63-18466 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE INFLUENCE OF HEATING RATE AND TEST STREAM OXYGEN CONTENT ON THE INSULATION EFFICIENCY OF CHARRING MATERIALS
Nick S. Vojvodich and Ernest L. Winkler Washington, NASA, July 1963 34 p 19 refs
(NASA TN-D-1889) OTS: $1.00

The insulation behavior of thin sections (1/10 of an inch) of some typical charring materials was studied at cold-wall convective heating rates between 5 and 120 Btu/ft^{2}sec in both arc-heated nitrogen and air. The insulation efficiency (the total cold-wall heat input per initial pound of material for a back-face temperature rise of 300° R) was used as a figure of merit in this investigation. Test results indicate that in both nitrogen and air the insulation efficiency is reduced as the heating rate is reduced. Furthermore, at the same cold-wall heating rate, the insulation efficiency measured in air was always lower than in nitrogen, with the most pronounced reduction occurring at the lowest rates. Temperature measurements of the material surfaces were higher in air than in nitrogen, suggesting that the effect of air environment on material performance is a consequence of exothermic combustion reactions. Author

N63-18492 Electro-Optical Systems, Inc., Pasadena, Calif.
FUEL CELL ASSEMBLIES **Second Quarterly Report, 10 July to 10 Oct. 1962**
Harvey Frank Oct. 15, 1962 30 p
(JPL Contract 950258)
(NASA CR-50565; EOS-3070-Q-2) OTS: $2.60 ph, $1.10 mf

The major portion of the experimental activities consisted of completing the fabrication, assembly, and initial testing of the first multicell unit regenerative hydrogen–oxygen fuel cell. The tests consisted of measuring the voltage-current and discharge characteristics for short cycles, internal temperatures, leak tightness, and capacity. Related fuel-cell investigations were concerned with methods for increasing cell capacity, and optimization of the catalyst. Materials studies were concerned primarily with evaluating high-temperature plastics for the cell spacers. Analytical activities consisted of evaluating the potential safety hazards that may exist in the operation and handling of this type of cell. Also included were design calculations and preliminary planning for the development of the final units. Author

N63-18496 Naval Research Lab., Washington, D.C.
OPTICAL CONSTANTS OF METALS IN THE EXTREME ULTRAVIOLET. I. A MODIFIED CRITICAL ANGLE TECHNIQUE FOR MEASURING THE INDEX OF REFRACTION OF METALS IN THE EXTREME ULTRAVIOLET
W. R. Hunter [1963] 25 p 8 refs Submitted for Publication
(NASA Order R-21)
(NASA CR-50265) OTS: $2.60 ph, $0.95 mf

A simple method for measuring the index of refraction, n, of substances that have an index less than unity and a very small extinction coefficient has been developed. It is similar to the usual critical angle method which measures the index by direct location of the critical angle. The presence of a small amount of absorption makes direct location of the critical angle impossible, since it erases the discontinuity in the slope of the reflectance versus angle-of-incidence curve, on which the critical angle method depends. The angle at which the slope of the curve is a maximum very nearly equals the critical angle, however, so that instead of determining n from the position of a discontinuity in the slope of the reflectance versus angle-of-incidence curve, it may be obtained from the angle of maximum

slope. Four sources of error, which cause the position of maximum slope to shift away from the critical angle, are: large values of k; the presence of an absorbing layer, such as an oxide; interference effects that may be present if the sample to be studied is in the form of a layer on a substrate; and polarization of the incident radiation. The magnitude of the errors arising from these effects are discussed, and the method is compared with an interference method for measuring n. Author

N63-18592 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.
SCALING PROBLEMS ASSOCIATED WITH UNSTABLE BURNING IN SOLID PROPELLANT ROCKETS
R. W. Hart and J. F. Bird *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 993–1004 24 refs (See N63-18501 17-26)
(Contract NOw-62-0604-C)

The general problem of acoustic instability was surveyed at a panel session of the Eighth International Symposium on Combustion. At that time, emphasis was placed on the kinds of experimental measurements which would be necessary before our understanding of the phenomena could be put on a quantitative and practically useful basis. The nature of the role of theory in reaching for this goal was also considered. Since that time, much new research has been undertaken and much progress has been made. Accordingly, it seems to us that a reexamination of our status *vis-à-vis* the objective of a practical understanding could be valuable, particularly in focusing attention on essential unresolved problems, but also, partly, in enhancing a general awareness of recent progress and present activity. This reexamination is undertaken here within the restricted framework associated with scaling oscillatory instability. Author

N63-18642 Picatinny Arsenal. Ammunition Group, Dover, N.J.
GRAVITY GRADIENT MEASUREMENTS
Wilheim J. Lohninger July 1962 73 p 18 refs
(PA-TM-147-62)

The behavior of specific force receivers, defined as active or dynamic sensors, when affected by gravitational, linear, and centrifugal accelerations is theoretically investigated. The capability of these sensors is to: (1) sense gravitational, linear, and centrifugal accelerations; (2) measure the gradient of a gravitational field; (3) determine the direction of the gravity gradient or the local vertical; and (4) sense the state of a body falling freely, along a gradient line, taking as an example a miniaturized, commercially available sensor. This investigation is primarily concerned with the physics of the suggested types of active sensors and of one or more dimensional assemblies of such sensors, their development, improvement of their sensitivity, and their testing by methodic experiments and accurate measurements. Author

N63-18660 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
POSITRON-HYDROGEN SCATTERING
Aaron Temkin Washington, NASA, Aug. 1963 20 p 12 refs
(NASA TN D-1849) OTS: $0.75

The nonadiabatic theory of electron-hydrogen scattering is applied to s-wave scattering of positrons by atomic hydrogen. This zeroth-order problem is considerably more difficult than the corresponding one for electron-hydrogen scattering. If we assume that the most extensive of Rotenberg's calculation relating strictly to the zeroth-order problem is an adequate approximation, then the present calculations support the conclusion that his final phase shifts are more correct than those of Schwartz. The nonadiabatic theory is also developed for higher partial wave scattering. The portion of the coupled set of equations which gives the major contribution to the phase shifts can readily be isolated. A first approximation of the truncated p-wave equations is obtained; the corresponding phase shifts are found to be positive, but much smaller than those of Bransden. Author

N63-18708 Utah U. Microwave Devices Lab., Salt Lake City
SPACE-CHARGE EFFECTS IN CYCLOTRON WAVE DEVICES
T. W. Kao and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 36–41 1 ref
(See N63-18701 17-09)
(Contract Nonr-1288(05))

The role that space charge forces play in the operation of cyclotron wave devices, particularly d.c. pumped parametric amplifiers, is investigated. The first application will be for fast-cyclotron wave interaction with the negative-energy synchronous wave. The couple mode theory is modified by the presence of space charge forces. Under conditions of axial symmetry and constant magentic field, the coupling between modes by a d.c. electric field pattern $E_z = -E_p \sin \beta_p z$ is given. N.E.A.

24 PHYSICS, PLASMA

Includes: fusion; and magnetohydrodynamics.

For related information see: 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

N63-18247 Aerospace Corp. Plasma Research Lab., El Segundo, Calif.
A SURVEY OF SOME PLASMA ACCELERATION DEVICES FOR SPACE PROPULSION APPLICATIONS
D. M. Dix May 17, 1963 50 p 27 refs
(Contract AF 04(695)-169)
(TDR-169(3713-01)TR-1; SSD-TDR-63-120)

The current status of pulsed plasma accelerators and steady-state $\underline{j} \times \underline{B}$ accelerators is summarized. Emphasis is placed upon three areas of the current state of knowledge: the basic interaction by which acceleration is accomplished; the loss mechanisms which exist in a given type device; and experimental results relevant to either of these two factors, as well as results of performance measurements. Author

N63-18294 Hughes Research Labs., Malibu, Calif.
CESIUM PLASMA STUDIES FOR THERMIONIC ENERGY CONVERSION Semi-Annual Technical Summary Report
J. Y. Wada and R. C. Knechtli Dec. 1962 24 p 8 refs
(Contract Nonr-3501(00), Phase II)

The thermalization of an electron stream injected at a controlled energy (up to 7 ev) into a quiescent cesium plasma has been observed. The plasma heating associated with the thermalization of the injected electrons has been measured and was found to be in general agreement with theoretical expectations. This constitutes an important step towards an understanding of the mechanisms of electron injection in gas discharges or plasmas, in such devices as thermionic energy converters, gas discharge tubes, and ion engines for space propulsion. The resistivity of a highly ionized quiescent cesium plasma has been measured for small current densities (negligible ohmic heating of the plasma), at temperatures between 2000° and 2500° K. The measured values of resistivity were found to be in good agreement with those theoretically predicted by Spitzer. This is a significant result because it constitutes, to our knowledge, one of the first unequivocal

measurements of the resistivity of a highly ionized quiescent plasma. These measurements also constitute the first step towards the investigation of ohmic plasma heating as it occurs, for example, in thermionic energy converters. Author

N63-18368 Massachusetts Inst. of Tech. Lab. for Nuclear Science, Cambridge
DIRECT OBSERVATIONS OF THE INTERPLANETARY PLASMA
C. Dilworth (Instituto Nazionale de Fisica Nucleare), E. F. Lyon (Lincoln Lab.), H. S. Bridge, A. J. Lazarus, and F. Scherb Repr. from J. Phys. Soc. Japan, v. 17, Suppl. A-11, 1962 p 553–560 5 refs Presented at the International Conf. on Cosmic Rays and the Earth Storm, Pt. II
(NASA Contract NASw-75)
(NASA CR-50446)

Some preliminary results obtained with the earth satellite Explorer X (1961 kappa) are presented. This satellite was designed to measure properties of the magnetic field and of the ionized gas (plasma) over a region starting close to the earth and extending to a point where effects of the earth's magnetic field should be negligible. The orbit was very eccentric (apogee 240,000 km; perigee 300 km), and the experiments included two types of magnetometers (Goddard Space Flight Center) and a plasma probe (Massachusetts Institute of Technology). When the plasma experiments for Explorer X were planned, there were no direct experimental observations of the plasma. Indirect observations and various theoretical treatments resulted in greatly divergent views of the situation in the interplanetary region. For this reason, an experiment was designed which could explore the appropriate physical quantities over a wide range. In particular, the experiment was planned to measure the flux of plasma protons, and give a crude estimate of the energy, spatial, and temporal distributions. Author

N63-18394 United Aircraft Corp. Research Labs., East Hartford, Conn.
RESEARCH ON THE COLLISION PROBABILITIES OF ELECTRONS AND CESIUM IONS IN CESIUM VAPOR Final Report, May 1, 1962–May 31, 1963
R. H. Bullis and R. K. Flavin May 31, 1963 51 p 10 refs
(NASA Contract NASr-112)
(NASA CR-50301; A-920057-5) OTS: $5.60 ph, $1.73 mf

The collision cross sections of ions and electrons in cesium vapor were determined by an experimental research investigation. Values for these cross sections permit the formulation of a quantitative analysis of the operation of thermionic converters or other devices employing cesium vapor in an ionized state. Electron cyclotron resonance techniques were employed to determine the electron collision cross sections, and a modification of the Ramsauer experiment designed to eliminate contact potentials was employed to determine the ion collision cross sections. The collision cross sections for electrons with cesium atoms were determined to vary from 1150 to 1500 P_c (collisions per centimeter at one millimeter gas pressure) at energies of 0.05 and 0.10 ev, respectively, with a maximum cross section of 1900 P_c at .065 ev. The collision cross sections of ions with cesium atoms were determined to vary from 5,685 to 25,570 P_c at energies of 9.7 to 0.12 ev, respectively. Author

N63-18404 Sylvania Electric Products, Inc., Waltham, Mass.
MAGNETOHYDRODYNAMIC WAVES IN A CONSTANT DIPOLE MAGNETIC FIELD
John Carstoiu (Science for Ind., Inc.) Repr. from Proc. Natl. Acad. Sci., v. 48, no. 6, June 1962 p 990–996 4 refs
(NASA Contract NASr-18)
(NASA CR-50216)

The magnetohydrodynamic behavior of an electrically conducting fluid in terms of generalized Alfvèn waves by means of vorticity and current density is investigated. Solutions are discussed only for large distances from the center of the dipole. Geometry of lines of the dipole is discussed. N.E.A.

N63-18630 Plasmadyne Corp., Santa Ana, Calif.
TYPICAL INORGANIC AND ORGANIC HIGH TEMPERATURE PLASMAJET REACTIONS
R. A. Damon and D. H. White (Ariz. U.) Sept. 20, 1962 21 p
(PLR-119)

The reaction steps of one inorganic reaction and one organic reaction from a plasmajet standpoint are discussed. The basic criteria for this study are that both reactions should (1) have a good chance of actually occurring when tried in a plasmajet facility, (2) have at least fair economics, and (3) be of interest to various chemical process industries. The inorganic reaction discussed is the reduction of phosphate rock to elemental phosphorous. Thermodynamic studies indicate that the reduction of phosphate rock to elemental phosphorous reaction should be successful in a plasmajet facility. Thermodynamic studies indicate that the reduction of phosphate rock to elemental phosphorous reaction should be successful in a plasmajet facility. The organic reaction discussed is the production of a reducer gas from methane (or other light hydrocarbons in certain cases), consisting of a mixture of carbon monoxide and hydrogen. The plasmajet could serve as an ideal reactor for the production of hydrogen from hydrocarbons by steam reforming, oxygen reforming, or a combination of both, depending upon the type product gas desired. Plasmajet steam reforming of hydrocarbons is thermodynamically feasible, resulting in the production of a reducer gas consisting primarily of H_2 and CO_2 and essentially uncontaminated with CO_2 and steam. N.E.A.

N63-18652 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
RESONANCE IN A COLD MULTICONSTITUENT PLASMA AT ARBITRARY ORIENTATION TO THE MAGNETIC FIELD
Eli Reshotko Washington, NASA, July 1963 26 p 12 refs
(NASA TN D-1875) OTS: $0.75

The sensitivity of resonant frequency to the orientation of the propagation vector has been examined for plasmas having both single and multiple ion species. For propagation at right angles to the magnetic field, the hybrid resonances of Auer, Hurwitz, and Miller and of Buchsbaum are obtained. However, at high plasma density, if the direction of the propagation vector departs even slightly from 90°, each of these resonances shifts quickly to a higher frequency approaching the next single-species cyclotron frequency, and an additional resonance appears at a frequency below the lowest single-species cyclotron frequency. In the limit of high plasma density, all the aforementioned resonances have the common property that there is no net current in the direction of the electric field. Author

N63-18712 Utah U. Microwave Devices Lab., Salt Lake City
WAVES IN PLASMAS
P. O. Berrett and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 51–57 1 ref
(See N63-18701 17-09)
(NSF Grant G-15017)

The objective of this investigation is to study plasma-wave propagation in waveguides or microwave circuits and the interaction of these waves with electron beams for use as millimeter wave signal generators. The associated problem of coupling RF power from the beam plasma region to a suitable antenna system is also being considered. Attention has been given to obtaining the general dispersion relationship for a circular

cylinder plasma column with general admittance walls. With such a dispersion equation, the effect of various structures surrounding the plasma column could be studied as special cases of the general equation without continual recourse to separate development. A few special cases were analyzed by an alternate approach and the results used as checks on the general equation. N.E.A.

N63-18713 Utah U. Microwave Devices Lab., Salt Lake City
PLASMA GENERATION AND MEASUREMENTS
Verle Gilson and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 58–84 10 refs
(See N63-18701 17-09)
(NSF Grant 15017)

Electron densities that have been determined by Langmuir double probes are compared with those determined by a microwave resonant cavity for a mercury arc discharge. The purpose is the accuracy of Klarfeld's prediction of electron density and temperature for small diameter discharges, and to obtain electron density characteristics of a 1-cm-diameter mercury discharge in the presence of a static axial magnetic field. N.E.A.

N63-18714 Utah U. Microwave Devices Lab., Salt Lake City
MICROWAVE PLASMA MEASUREMENTS
J. C. Lee and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 84–87 3 refs
(See N63-18701 17-09)
(NSF Grant 15017)

The object of this project is to investigate plasma waves experimentally for the purpose of verifying wave theory and providing a technique for measuring plasma parameters. In this period, the use of the transverse probes to excite the backward-wave modes was tried but no backward waves were observed. The collision frequency referring to close encounters between electrons and neutrals was estimated for a weakly ionized gas. From the attenuation results, it seems that the failure of observing a backward-wave mode is not due to the effect of distant collisions. N.E.A.

N63-18715 Utah U. Microwave Devices Lab., Salt Lake City
ROCKET EXHAUST STUDIES
A. S. Jones, C. C. Johnson, and R. W. Grow *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 87–88 (See N63-18701 17-09)
(Contract AF 04(647)-745)

The purpose of this project is to establish theoretical and experimental techniques for making measurements of electron concentrations in a plasma with microwave radiation. The plasma used in this project is the exhaust of a solid-fuel rocket engine. The exhaust is a stratified mixture of ionized gases and particles. During this period, microwave attenuation and reflection measurements were made at X- and K-band on a series of special engines developed for the purpose of studying the effect of contamination in the fuel. Chemical analyses were made prior to the firing of the motors. The tentative conclusion of the data is that, while qualitative correlation of microwave data with chemical analyses was obtained, chamber pressure variation produced significant variation in the measured electron density so that quantitative correlation is unavailable. N.E.A.

N63-18716 Utah U. Microwave Devices Lab., Salt Lake City
THERMIONIC EMISSION FROM CONDENSED SPECIES IN ROCKET EXHAUSTS
C. K. Bullock and C. C. Johnson *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 88–93 2 refs
(See N63-18701 17-09)
(Contract AF 04(647)-745)

The nature of a thermionically emitting particle in a hot plasma is considered. An electron cloud will be generated in the vicinity of the particle, and the interaction of this electron cloud will be considered. N.E.A.

N63-18741 Princeton U. Plasma Physics Lab., N.J.
LANDAU DAMPING OF ION ACOUSTIC WAVES IN HIGHLY-IONIZED PLASMAS
A. Y. Wong, R. W. Motley, and N. D'Angelo May 1963 29 p 20 refs
(Contract AT(30-1)-1238)
(MATT-177)

Ion acoustic waves with frequencies between 5 and 100 kc/sec have been excited in highly-ionized cesium and potassium plasmas by modulating the potential of a tungsten grid immersed in the plasma. The waves were detected by another grid, which could be moved along the plasma column. Because the plasma is produced at one end of the column, there is a net flow of plasma between the grids. Phase velocities of 1.3×10^5 cm/sec and 0.9×10^5 cm/sec along and against this drift were measured for cesium, and 2.5×10^5 cm/sec and 1.3×10^5 cm/sec for potassium. The damping distance of the waves was found to be independent of ion density in the range $3 \times 10^{10}\ \text{cm}^{-3} < n < 3 \times 10^{11}\ \text{cm}^{-3}$, and equal to 0.55 and 0.25 wavelength along and against the flow in cesium and 0.65 and 0.14 in potassium. A comparison between the results and the collisionless theory shows agreement within about 10%. In particular, it is shown how the present experiment provides a quantitative measurement of the Landau damping of ion acoustic waves. Author

N63-18743 Princeton U. Plasma Physics Lab., N.J.
LONG WAVELENGTH INSTABILITY IN A REFLEX DISCHARGE
Robert Bingham May 1963 26 p 10 refs
(Contract AT(30-1)-1238)
(MATT-198)

An examination of the stability of the reflex arc (P.I.G.) discharge against a long wavelength $m = 1$ instability has been carried out. In performing the calculation, use was made of the experimental plasma density distribution and the plasma potential distribution, as computed by Chen for a hot cathode P.I.G. in a strong magnetic field. It is found that the discharge is unstable for helical instabilities with wavelength greater than 1200 R cm, where R is the discharge radius. The growth rate increases with increasing wavelength. This result is consistent with that of Simon's analysis of a slab geometry with crossed electric and magnetic fields. Author

N63-18770 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ESTIMATES OF ATTENUATION AND REFLECTION OF TELEMETERING SIGNALS BY IONIZED FLOW FIELDS SURROUNDING TYPICAL REENTRY BODIES
Anthony J. Russo, Jr. Washington, NASA, Aug. 1963 90 p 28 refs
(NASA TN D-1778) OTS: $2.25

Estimates of the degree of signal loss due to attenuation and reflection by the inviscid equilibrium plasma sheath were made for spherically blunted cones with half-angles of 30°, 8°, and 0°, at Mach numbers as high as 25, 20, and 19.25, respectively. The computations were made for transmitting frequencies of 30 mc, 240 mc, and 10,000 mc, and over the altitude range from 60,430 feet to 230,000 feet. Calculations, utilizing the simplest application of electromagnetic theory, were made by using normalized body-shape parameters, and methods for applying the resulting tabulated data to specific

vehicle reentry problems are discussed. The possible significance of viscous interaction and nonequilibrium effects on the applicability of the results to a given problem is discussed briefly. Charts of the electromagnetic properties of equilibrium air for temperatures from 3,000° K to 7,000° K are presented, from which attenuation and reflection estimates can be made when the density and temperature distributions are known. Author

25 PHYSICS, SOLID-STATE

Includes: semiconductor theory; and masers.

For related information see: 09 Electronics; 23 Physics, General; and 24 Physics, Plasma.

N63-18259 Cornell U. Lab. of Atomic and Solid State Physics, Ithaca, N.Y.

INVESTIGATIONS ON SOME ALKALI HALIDES IN THE VACUUM ULTRAVIOLET

P. L. Hartman Repr. from J. Quant. Spectr. Radiative Transfer (London), v. 22, [1962] p 579–587 21 refs
(NASA Grant NsG-212; Nonr-401(47))
(NASA CR-50400)

Optical and photoemission properties of alkali halides, and properties of some of the halide crystal centers occurring in them as revealed both by absorption and luminescent properties are reviewed. N.E.A.

N63-18288 Ohio State U. Research Foundation. Antenna Lab., Columbus

IONIZATION OF GASES BY OPTICAL MASER RADIATION

E. K. Damon and R. G. Tomlinson Nov. 30, 1962 9 p refs
(Contract AF 33(616)-7081)
(Rept. 1083-19)

Apparent ionization of noble and atmospheric gases in a focused laser beam has been observed. The effect shows a strong nonlinearity and appears to be power dependent rather than energy dependent. The results of preliminary measurements using conventional and Q-switched laser pulses are included. Author

N63-18298 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

SPECTRAL EMISSIVITIES OF ELECTRODE MATERIALS

J. R. Branstetter Repr. from Advanced Energy Conversion, v. 3, 1963 p 295–303 20 refs

The present paper discusses current progress towards obtaining spectral emissivity data on materials (such as tantalum); the amount of emissivity data required for any given material in order to calculate summed net heat flows having good accuracy; and the extent to which simple equations can be made to fit these heat-flow data. The analytical procedure used by the NASA data-reduction center to compute net heat flux for particular geometries is mentioned. Emphasis is placed on how the procedure can be applied to a variety of geometries and materials. Author

N63-18393 Brown U. Metals Research Lab., Providence, R.I.

ULTRASONIC METHODS IN THE STUDY OF FATIGUE AND DEFORMATION IN SINGLE CRYSTALS [Final Report, Feb. 1, 1962–Feb. 1, 1963]

Bruce Chick, Akira Hikata, George Anderson, William Findley, Rohn Truell, and Charles Elbaum Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Apr. 1, 1963 82 p 31 refs
(Contract AF 33(657)-8324)
(ASD-TDR-62-186, Pt. II)

The use of ultrasonic methods (and in some cases electrical-conductivity measurements) for studying defect formation and motion in connection with deformation and stress cycling experiments in aluminum and sodium chloride single crystals is outlined. Measurements on large single crystals of sodium chloride, deformed in tension, have been made in a manner similar to that with aluminum for the purpose of comparing the dislocation damping and recovery effects in an ionic crystal with those in a metal. In addition, there is significant information from electrical-conductivity measurements made concurrently with attenuation and velocity measurements. Recovery in aluminum single crystals at 195° K has been compared with recovery at room temperature, with the result that an interesting "threshold effect" has been observed; there appears to be a level of deformation which must be exceeded at this temperature before recovery occurs. Stress cycling experiments on aluminum single crystals cycled in tension and compression have shown some interesting consequences in comparison with earlier results on polycrystalline samples. Single crystals (high purity) can be cycled at levels much higher relative to yield stress and breaking stress than can polycrystalline (commercial purity) samples; at the same time the stress level can be raised in steps during cycling until it is one and a half to two times (at least) the stress that would be required initially to break the single crystal sample. Author

N63-18399 Cornell U. Lab. of Atomic and Solid-State Physics, Ithaca, N.Y.

ULTRAVIOLET ABSORPTION OF KI DILUTED IN KCl CRYSTALS

Herbert Mahr Repr from Phys. Rev., v. 125, No. 5, Mar. 1, 1962 p 1510–1516 24 refs
(NASA Grant NsG-212)
(NASA CR-50402)

The absorption of KI diluted in KCl single crystals was studied for concentrations of 10^{-3} to 10^{-5} mole fraction KI in the temperature range from 80° K to 700° K. The exact shape of the long-wavelength absorption peak, which is gaussian around the maximum and exponential at the edge, was measured quantitatively over four orders of magnitude. The total integrated absorption is proportional to the iodide concentration which was determined chemically. In the limit of high temperatures, the half-width of the band is proportional to the square root of the temperature and the edge follows Urbach's law. Deviations at low temperatures were shown to arise from zero-point oscillations. The results were compared with models for localized excitons. Author

N63-18400 Rice U., Houston, Tex.

PHYSICS OF SOLID MATERIALS Semiannual Status Report 8, Nov. 1, 1962–Apr. 30, 1963

Franz R. Brotzen [1963] 18 p 18 refs
(NASA Grant NsG-6-59)
(NASA CR-50456) OTS: $1.60 ph, $0.80 mf

Research for the following fields is summarized: (1) solid-state physics, (2) physical metallurgy, and (3) chemistry of solids. P.V.E.

N63-18425 Carnegie Inst. of Tech., Pittsburgh, Pa.
MAGNETIC SUSCEPTIBILITY OF $Cu(NO_3)_2 2.5H_2O$ AT LOW TEMPERATURE
L. Berger, S. A. Friedberg, and J. T. Schriempf June 12, 1963 18 p 18 refs Submitted for Publication
(Contract Nonr-760(05))
(Tech. Rept. 16)

The magnetic susceptibility of cupric nitrate "trihydrate" $Cu(NO_3)_2 2.5H_2O$ has been measured on the powder and on single crystals in the 14° to 20° K and 0.4° to 4.2° K ranges of temperature. The susceptibility of the powder has a rounded maximum at 3.2° K, where it is equal to 0.065 CGS/mole, and drops very rapidly towards zero below this temperature. This behavior differs from that of a typical antiferromagnet. The experimental data have been compared with existing theoretical calculations for antiferromagnetic linear chains or binary clusters. In the single crystal, the susceptibility measured in a direction parallel to the monoclinic axis is always larger by 20% than the susceptibility in the perpendicular directions. This is probably due to a uniaxial anisotropy of the g factor. Author

N63-18484 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MECHANICAL ELEMENTS AND BEARINGS IN SPACE
W. R. Eulitz July 18, 1962 97 p 119 refs
(NASA TM X-50141; MTP-P&VE-P-62-4) OTS: $8.60 ph, $3.11 mf

In this study, three types of mechanical problems in space have been considered: (1) frictional characteristics under a high vacuum, (2) sealing of removable hatches, and (3) power transmission through a pressure barrier. The vacuum of space was simulated by a pressure in the order of 10^{-7} torr. It is concluded that friction is the consequence of molecular disorder in the interface between two mating surfaces. In space where conventional lubricants are inadequate, friction cannot be reduced to an acceptable minimum by ball, roller, or journal bearings. The problem must be attacked by methods of solid-state physics, which suggests the development of a special solid lubricant of extraordinary characteristics. Author

N63-18551 Cambridge U. (Gt. Brit.)
THE INITIATION AND GROWTH OF EXPLOSION IN THE CONDENSED PHASE
F. P. Bowden *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 499–516 32 refs
(See N63-18501 17-26)

The Slow Decomposition of Explosive Crystals: Electron microscope studies show that the thermal decomposition of some explosive crystals, e.g., silver cyanamide, occurs primarily on the surface. With others, e.g., silver azide, the surface reaction is again important but there is evidence also for some decomposition within the crystal which can cause it to break up into many small fragments. There is also evidence that, for many of these explosives, an actual melting must occur—it is only in the molten phase that the reacting species have sufficient mobility for a rapid acceleration to take place. *The Effect of Fission Fragments and Nuclear Radiation*: By choosing a crystal lattice which can be resolved in the electron microscope, it has been possible to measure the extent of the damage with some precision. The damage depends upon the nature of the crystal and on other factors, but the track width may be approx. 100–120 Å. The disorder produced in the lattice and the holes and tunnels formed may be clearly seen. The damage may be interpreted on a thermal mechanism. The experiments at present suggest that even the intersection of two tracks would not produce explosion in an azide crystal. The intersection of three or more tracks within 10^{-11} sec is an unlikely event. *The Effect of Discontinuities in Promoting Shock Initiation*: Recent experiments with single crystals emphasize the importance of very tiny defects in the initiation of explosion by weak shock waves and the part they play in the growth process. A perfect crystal of silver azide is not initiated by a shock but a defect only a few microns in size will start reaction. This reaction in small crystals (0.01 to 1 mm) is a fast burning one. With crystals greater than 2 mm, it may grow to detonation. Author

N63-18624 Stanford U., Calif.
A CONTRIBUTION TO THE THEORY OF ISOTROPIC LOCKING
Wilhelm Flügge and Hanagud V. Sathyanarayana Apr. 1963 164 p 4 refs
(Contract Nonr-225(30))
(SUDAER 152)

The phenomenon of isotropic locking in an ideal solid material is explained in order to characterize the mechanical behavior of locking materials. The general theory is explained, problems in volumetric and distortional locking and the equilibrium of the solid are detailed, and the manner of wave propagation in locking media is discussed. Examples of these materials are given, such as granular soil and rubber. D.E.R.

N63-18672 Technical Research Group, Syosset, N.Y.
RESEARCH ON PROPERTIES OF LASER DEVICES Fourth Quarterly Technical Summary Report, Mar. 1963–May 1963
M. Newstein and S. Rothberg, eds. [1963] 153 p 74 refs
(Contract AF 49(638)-673; ARPA Order 356-62; Proj. Defender)
(TRG-134-QTR-4)

Theoretical study of the performance of pulse oscillators was continued. Qualitative agreement was obtained with results of experiments dealing with the effects of varying cavity time constant and scattering loss. Crystalline and glassy media for rare-earth ions were studied. Work on laser pumping by the photodissociation of molecules was continued, and extended to include CsBr and CsI in addition to TlBr. Work on the metastable transition laser was begun. The noise power spectrum of a laser was investigated. Oscillation was achieved in more lasers with retroreflecting prism cavities, and their properties investigated. The study of Q-switched lasers was continued, and a new faster mechanical Q-switch was designed. Author

N63-18709 Utah U., Microwave Devices Lab., Salt Lake City
IRRADIATED LASER MATERIALS
V. R. Johnson and R. W. Grow *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 42–44 (See N63-18701 17-09)
(NSF Grant 15017)

Progress is reported on a project designed to investigate the possibility of reducing the pumping energy required for a solid-state ruby laser by γ-ray damage and by applying extremely high static pressure. A nitrogen-cooled ruby rod in elliptical laser cavity apparatus was constructed and tried. The apparatus proved unsuccessful. The rod was next γ-irradiated at room temperature for periods of the order of 15 to 25 hours. This amount of irradiation was sufficient to snuff out laser action in the crystal, at least for the input pump power available. The γ-damage in ruby was found to be annealed out by heating the crystal to about 400° C and at least partially annealed by optically pumping the crystal in a laser configuration. N.E.A.

N63-18710 Utah U. Microwave Devices Lab., Salt Lake City
TUNNELING STUDIES
M. D. Crawford and R. W. Grow *In its* Microwave Devices Lab., Consolidated Quarterly Rept. Mar. 31, 1963 p 45–47 (See N63-18701 17-09)
(Contract Nonr-1288(05))

The objective of this project is the study of a quantum mechanic tunneling through thin barriers with possible application to: (1) stimulated emission of radiation, (2) interaction with and/or modulation of electromagnetic radiation, and (3) electron emission into a vacuum for use as a low-noise cathode. During this period, research has been concentrated in the area of stimulated emission of radiation from GaAs laser diodes, particularly the modulation characteristics. Approximate calculation of theoretical upper limitations upon the frequencies at which GaAs laser diodes can be modulated are calculated. The limitations considered were (1) the transit time required for charge carriers to travel across the junction, and (2) the R-C cutoff frequency of the effective impedance of the junction consisting of the junction resistance in parallel with the junction capacitance. The calculations showed that the most significant limitation upon the frequency of modulation is the diode R-C cutoff frequency. Since this limitation is a function of the diode current and geometry, it is quite probable that these diodes can be constructed with modulation capabilities in the millimeter and submillimeter range. N.E.A.

N63-18711 Utah U. Microwave Devices Lab., Salt Lake City
MILLIMETER WAVE MASERS
J. C. Clark and R. W. Grow *In its* Microwave Devices Lab. Consolidated Quarterly Rept. Mar. 31, 1963 p 48–50 4 refs (See N63-18701 17-09)
(NSF Grant 15017)

Materials suitable for use in solid-state masers at millimeter wavelength are investigated. The primary activity of the report period consisted of literature search of both the current research concerned with millimeter wave maser materials and fundamental background information applicable for these cases. Both Eu^{++} in CaF and SrCl have been suggested as materials that may have an allowed microwave transition that can be inverted near one of the levels of the optical transition. One other type of material that is potentially worth consideration for use in the millimeter wavelength region is a solid-state maser using the cyclotron resonance levels and impurity doping levels in semiconductors. N.E.A.

N63-18769 Alfred U. New York State Coll. of Ceramics
ELASTIC PROPERTIES OF POLYCRYSTALLINE MAGNESIUM-ALUMINATE SPINEL Progress Report No. 6
Dae-Hyun Chung, Peter O. Benson, and William B. Crandall June 15, 1963 42 p 17 refs
(Contract DA-31-124-ARO(D)-23)
(AROD-2891-7)

Dense specimens of magnesium-aluminate spinel with varying mole ratios of magnesia to alumina were prepared. The room temperature values of the elastic moduli were determined as a function of microstructure. Young's modulus of the 1:1, 1:2.25, and 1:3.5 magnesium-aluminate spinel as a function of temperature was measured. The results are discussed with respect to porosity, composition, and temperature. A method of studying stress-relaxation processes is given, with an emphasis on the application of the theory to the current research program. Author

26 PROPELLANTS AND COMBUSTION

Includes: fuels; igniters; and oxidizers.

For related information see: 07 Chemistry; and 27 Propulsion.

N63-18342 Reaction Motors Div., Thiokol Chemical Co., Denville, N.J.
INVESTIGATION OF ADVANCED HIGH ENERGY SPACE STORABLE PROPELLANT SYSTEM – OF_2/B_2H_6
Rolland R. Schreib, Jr. (Bellcomm, Inc.) and Bruce E. Dawson N. Y., Am. Inst. of Aeron. and Astronautics [1963] 14 p Presented at the AIAA Summer Meeting, Los Angeles, June 17–20 1963
(NASA Contract NASw-449)
(AIAA Paper 63-238) AIAA: $0.50 members, $1.00 nonmembers

The feasibility of oxygen difluoride-diborane propellants for use in space propulsion systems was investigated. Tests show that the OF_2-B_2H_6 propellant combination is hypergolic at both sea level and high altitude. High theoretical performance is readily attainable with standard injection techniques. The propellants can be easily handled in equipment suitable for the cryogenic temperature range when the components have been properly cleaned and passivated. Heat rejection rates are high due to the combination of high combustion temperatures and radiating combustion products, but the heat fluxes are within the present state-of-the-art for ablative chambers and nozzles. Author

N63-18360 Astropower, Inc., Newport Beach, Calif.
INVESTIGATION OF ZEOLITE MEMBRANE ELECTROLYTES FOR FUEL CELLS Quarterly Progress Report for Period Ending Sept. 1962
A. D. Kelmers, A. E. Levy-Pascal, N. Michael, and M. J. Plizga 1962 27 p 7 refs
(NASA Contract NAS7-150)
(NASA CR-50566; Rept. 108-Q1) OTS: $2.60 ph, $1.01 mf

The purpose is to evaluate the potential applicability of various synthetic zeolites, such as hydrated solid electrolytes, by investigating their physical and electrochemical properties. Crystalline zeolite powders are to be bonded into thin disks or membranes which will be assembled into thin composite wafers. The physical and electrochemical properties to be investigated are: (1) physical strength, (2) electrochemical conductivity, (3) gas permeability, (4) water adsorption isotherms or isosteres, (5) hydrogen–ion exchange, and (6) chemical stability. During this report period, procedures for the initial screening tests of different zeolites and binders have been established, and apparatus has been constructed. Progress has been made towards selecting a suitable binder. Measurements of the modulus of rupture indicated that zirconium phosphate bonded zeolites produced membranes having a transverse strength in the order of 1000 psi. Preliminary tests also indicated that membranes of satisfactory physical strength could be prepared with 10% to 15% epoxy resin employed as a binder. Additional testing of these membranes, in particular, ionic conductivity and water permeability measurements, are under way. N.E.A.

N63-18501 Combustion Inst., Pittsburgh, Pa.
NINTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION [HELD AT] CORNELL UNIVERSITY, ITHACA, NEW YORK, AUGUST 27 TO SEPTEMBER 1, 1962
W. G. Berl, ed. (Appl. Phys. Lab.) N.Y., Academic Press, 1963 1106 p refs
(NASA Grant NsG-245-62; Grants NSF 20174 and NSF 21506; and Contract DA-36-034-ORD-3534RD)
(NASA CR-50312)

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98. MODELING TECHNIQUES FOR LIQUID-PROPELLANT ROCKET COMBUSTION PROCESSES R. B. Lawhead and L. P. Combs (Rocketdyne) p 973–981 2 refs (See N63-18590 17-26)

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109. CLASSIFICATION OF FUELS: THERMODYNAMIC AND REACTION KINETIC PROPERTIES IN OTTO ENGINES F. A. F. Schmidt (Rheinisch Westfälische Tech. Hochschule, (W. Germany) p 1088 (See N63-18600 17-26)

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N63-18502 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

FLAME STRENGTH OF PROPANE-OXYGEN FLAMES AT LOW PRESSURES IN TURBULENT FLOW

Evelyn Anagnostou and A. E. Potter *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1–6 7 refs (See N63-18501 17-26)

The apparent flame strength, a unique combustion measurement described previously by Potter and co-workers, was investigated for the system propane-oxygen in turbulent flow at low pressures. The dependence of flame strength on pressure and on burner diameter was determined at Reynolds numbers ranging from 2000 to 10,000, for pressure between 0.17 and 0.85 atm and burner diameters ranging from 0.398 to 0.635 cm. The results were compared with those predicted by a theory developed recently by Spalding, according to which the flame strength should vary directly with burner diameter and the pressure dependence of the flame strength should be the same as the reaction order when the Reynolds number of the flow is sufficiently high. The results of this study show that the theoretical predictions are correct, provided that the Reynolds number is over 2000. This study shows that, under proper conditions, flame strength is a useful and meaningful measurement for characterizing fuel-oxidant systems. It differs from other flame properties in that it is independent of transport properties. Its most important use may be in studying fuel-oxidant systems which are difficult to mix. Author

N63-18504 Atlantic Research Corp., Alexandria, Va.

TURBULENT FLAMES STUDIES IN TWO-DIMENSIONAL OPEN BURNERS

J. R. Grover, E. N. Fales, and A. C. Scurlock *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 21–35 13 refs (See N63-18501 17-26)

The newly devised techniques for studying the effects of turbulence on homogeneous gas flames in two-dimensional open burners through the determination of (1) the mean flow field in the neighborhood of the flame front, (2) the position of the mean flames front and the root-mean-square displacement of the mean flame front, (3) the local turbulent flame velocity, and (4) the position of the instantaneous flame front have been refined and extended to several conditions of flow, turbulence, air-fuel ration, and burner size. This technique has also been extended to study the growth of wrinkles in the instantaneous flame front by high-speed photography. The experimental results obtained indicate the following: (1) For all of the conditions investigated, the effect of turbulence on the flame is only to wrinkle and extend the surface of the flame front. (2) The ratio of the local turbulent flame velocity to the laminar flame velocity S_T/S_L, can be correlated, as indicated in the previously presented theory of Scurlock and Grover, with the dimensionless time parameter, $S_L t/l_2$ (where t is the time of exposure of the flame element to the turbulence and l_2 is the Eulerian scale of turbulence), and the dimensionless turbulence intensity in the approach flow v_o'/S_L (where v_o' is the turbulence intensity). (3) S_T/S_L can be correlated with the root-mean-square displacement of the mean flame front, $(\overline{Y}^2)^{1/2}$. These results also verify that a useful technique has been developed for studying the effects of turbulence on flames. Author

N63-18505 Massachusetts Inst. of Tech., Cambridge

FLAME PROPAGATION IN LAMINAR BOUNDARY LAYERS

T. Y. Toong, J. R. Kelly, and W. S. Wu (IBM) *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 59–64 9 refs (See N63-18501 17-26)
(Grant NSF-7039)

Results are presentedof an experimental program aimed at providing a critical test of the equilibrium theory of flame stabilization in boundary layers previously proposed by the senior author. Using schlieren photography and a particle-track technique, the characteristics of a two-dimensional flame stabilized on a cylindrical rod and propagating into a laminar boundary layer adjacent to a flat plate are investigated. The results presented include the velocity distribution of the unburned mixture in the free stream, the velocity profile in the boundary layer, and the experimental burning-velocity profiles for three different plate temperatures. The latter profiles are compared with the adiabatic profiles computed on the basis of a previous theoretical analysis, and the effect of quenching due to the presence of the flat plate is discussed. The steps which lead to the experimental burning-velocity profiles are carefully examined and compared with available theoretical results. In each case, the comparison adds weight to the experimental findings. Finally, it is shown that the burning-velocity profiles are indeed affected by the growth of the thermal boundary layer when the flat plate is heated, and that these profiles assume shapes postulated in the theoretical study of the mechanism of flame stabilization. Quantitatively, the flameholding characteristics of a smooth surface predicted by the use of these measured profiles agree with reported experimental results. Author

N63-18506 Instituto Nacional de Técnica Aeronáutica, Madrid (Spain)

ON THE STRUCTURE OF PREMIXED AND DIFFUSION LAMINAR SPERICO-SYMMETRICAL FLAMES

P. Pérez del Notario and C. Sánchez Tarifa *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 65–71 9 refs (See N63-18501 17-26)
(Sponsored by AFOSR)

Premixed and diffusion laminar spherico-symmetrical flames are studied by means of a nonadiabatic model which considers variable temperature at infinity. The flame is supposed to be maintained by a porous sphere through which the gaseous mixture of one of the reactant gases is injected. Stationary conditions are assumed and chemical kinetics of the process is approximated by means of an overall reaction rate.

Solution of the problem is achieved by means of an approximate analytical method. Flame temperature, mass flow per unit area at the flame surface, thickness and radium of the flame, and temperature at the sphere surface are given as functions of the mass flow. The influence of the main parameters of the process—temperature at infinity, dimensionless ratio of the activation energy to the heat of reaction, and sphere radius—is also considered. Some experimental results for diffusion flames are also given in the paper. Author

N63-18507 New York U., N.Y.
A THEORETICAL STUDY OF SOME PROPERTIES OF LAMINAR STEADY STATE FLAMES AS A FUNCTION OF PROPERTIES OF THEIR CHEMICAL COMPONENTS
E. S. Campbell, F. J. Heinen, and L. M. Schalit *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 72–80 18 refs (See N63-18501 17-26)
(Contract AF 49(638)-169)

This paper combines results of three different types of studies in an attempt to begin developing a mathematical and physical understanding of (1) how certain flame properties depend upon the characteristics of the flame gases, and (2) the significance of some approximations which have been introduced into flame theories. The types of studies are: (a) the construction of the functional form of the general asymptotic solutions to the hydrodynamic equations for laminar steady-state flames as a function of the distance; (b) construction of different methods of solving the equation systems; (c) numerical studies of these equations for both hypothetical and real flames. Author

N63-18511 Sheffield U. (Gt. Brit.)
THE EMISSIVITY OF LUMINOUS FLAMES
R. G. Siddall and I. A. Mc Grath *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 102–110 9 refs (See N63-18501 17-26)

The results of previous experimental work on extinction coefficients have been expressed in the form $K\lambda = k\cdot\lambda^{-\alpha}$, where k is independent of the wavelength (λ) of the incident radiation. This paper describes the results of an experimental investigation into the values of α corresponding to soot layers deposited from a small laminar diffusion flame, on optically ground rock salt discs. The fuels used in the flame included amyl acetate, gas oil, petrotherm, towns gas, and some hydrocarbon gases. Extinction curves were obtained for each soot layer by means of an infrared spectrometer. The results are: (1) The variation of α with λ may be approximated by $\alpha + b \ln \lambda$ in some cases, and by a parabola in λ in others. (2) The "mean" α for any soot [obtained as the slope of the bestfit straight line to the results plotted in the form of graphs in $1n \cdot 1n\ (I_O/I_L)$ against $1n\ \lambda$] appears to be independent of the mean soot particle size. (3) α appears to be definitely correlated with the carbon-to-hydrogen ratio of the soot. A theoretical method is described, based upon the Mie theory, which permits the prediction of the variation of α with λ for any material at any temperature, provided that the optical properties of the material are known. The theory demonstrates that α is independent of particle size. An illustrative calculation is carried out for baked electrode carbon at 2250° K. For this case: (1) α is approximately constant for wavelength in the visible spectrum; (2) α is given within 3% by the equation $\alpha = 0.906 + 0.283\ 1n\ \lambda$ for the range $1\ \mu < \lambda < 10\mu$; (3) as $\lambda \to \infty$, α tends to an absolute maximum of 2. The method is extended to give a single curve from which the monochromatic emissivity of a cloud of particles of the specified material may be found for any wavelength and concentration of material. From this curve, the variation of total emissivity with particle concentration may be found by numerical integration. Author

N63-18512 Sheffield U. (Gt. Brit.)
THE THERMAL RADIATION THEORY FOR PLANE FLAME PROPAGATION IN COAL DUST CLOUDS
Robert H. Essenhigh (Penn. State U.) and Joseph Csaba (C.E.G.B., Gt. Brit.) *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 111–125 34 refs (See N63-18501 17-26)
(Supported by E.S.R.C., Gt. Brit.)

The Nusselt radiation theory of steady-state propagation of a plane flame through a dust cloud has been extended to take into account: a finite temperature difference between the particles and air, and a finite preignition zone (implying finite ignition time or distance). The dust cloud is assumed to be monodisperse, formed by the suspension of finely ground coal in air. As the ignition temperature of coal dust is believed to be the coal decomposition temperature, this is a constant, independent of the ambient conditions, and it therefore effectively decouples the preignition and flame zones; this means that the preignition zone can be treated independently of the flame. The dust in the preignition zone is assumed to be heated by radiation from the flame alone; conduction is neglected. Part of the radiant heat absorbed by the particles is then lost by conduction to the surrounding gas. The gas temperature therefore lags behind that of the particles. Because of this heating, however, the gas expands with the consequence that the gas density and the dust concentration (and therefore the radiation-attenuation coefficient) all drop. The system, as specified, is governed by two simultaneous ordinary differential equations, and analytical solutions for the respective rise of the particles and gas temperatures have been found. In the limiting case, when the particle temperature reaches ignition, the solution for the particle temperature provides an expression for the flame speed. Author

N63-18513 Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.
FLAME CHARACTERISTICS OF THE DIBORANE-HYDRAZINE SYSTEM
M. Vanpée, A. H. Clark, and H. G. Wolfhard *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 127–136 33 refs (See N63-18501 17-26)
(Contract Nonr-1858(25); Proj. Squid)

Premixed flames of diborane-hydrazine have been stabilized at low pressures and a number of their characteristics (stability region, burning velocity, reaction products, light emission) have been established. The flame could only be stabilized at pressures below 50 mm Hg because of adduct formation occurring at higher pressures. The main features of the flame are a high burning velocity (5 m/second), a low reaction temperature ($\simeq$ 1100° C) and the absence of any light emission other than a continuum from solid particles. The data support the view that originally a gaseous adduct is formed between diborane and hydrazine that grows by polymerization and dehydrogenation to form the final solid products of the flame. Author

N63-18514 Leeds U., (Gt. Brit.)
STUDIES OF THE COMBUSTION OF DIMETHYL HYDRAZINE AND RELATED COMPOUNDS
Peter Gray and Malcolm Spencer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 148–157 8 refs (See N63-18501 17-26)
(Supported by Min. of Power)

Spontaneous ignition studies are here reported on hydrazine and (unsymmetrical) dimethyl hydrazine. This paper is part of a general program on the combustion of endothermic fuels: (1) Hydrazine systems: $N_2H_4 + NO$; $N_2H_4 + N_2O$.

The work on hydrazine concerns the $N_2H_4 + NO$ and $N_2H_4 + N_2O$ systems. Particular aims are to establish the modes of reaction, to investigate the critical conditions for ignition, and to investigate the possible thermal character of the explosion. In mixtures with nitric oxide there is either slow reaction or explosion. The stoichiometric mixture ($N_2H_4 + 2NO$) is the most ignitible. The influence of inert diluents and comparison with $N_2H_4 + O_2$ suggests that explosion is thermal in character. The ready ignition is correlated with the postulated reactivity of nitric oxide towards radicals such as NH and NH_2. In mixtures with nitrous oxide, explosion appears to be initiated as if nitrous oxide were merely a diluent although the nitrous oxide does not survive the flame. (2) Dimethyl hydrazine systems: $Me_2NNH_2 + O_2$. There is very little previous published work on dimethyl hydrazine (DMH) combustion. The conditions for DMH to undergo spontaneous ignition both in decomposition and in oxidative combustion have been examined. Distinct modes of oxidation exist. They include strong explosions, weak ignition, chemiluminescent oxidation, and slow reaction; in addition, multiple ignitions have been observed. Qualitatively, the combustion differs markedly from that of the superficially analogous mono-, di-, and trimethylamines although there are resemblances to the ethylamines. Author

N63-18516 Imperial Coll. of Science and Tech., London (Gt. Brit.)

ISOTOPIC CARBON AS A TRACER IN COMBUSTION RESEARCH

C. F. Cullis, A. Fish, and D. L. Trimm *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 167–176 16 refs (See N63-18501 17-26)

Several researches are described in which the solution of combustion problems has been facilitated by the use of carbon-13 and carbon-14 tracer methods. One of the widest applications is in the elucidation of the mechanism of formation of combustion products and some work is described in which the position of the isotopic carbon has been determined in the principal products formed from $[2-C^{14}]$ and $[4-C^{14}]$-2-methyl-but-2-enes. Another use is in the determination of the most probable points of oxidative attack of fuel molecules. In this connection, 2-methylpentane has been labeled specifically in all its skeletal positions, and the isotopic enrichment of the final combustion products has been measured. The technique of isotopic labeling has also been applied to discover which component of a mixed fuel is responsible for the formation of a given product; thus measurement of the activity of the carbon deposits formed from samples of gasoline containing each constituent labeled in turn with carbon-14 gives quantitative information about their deposit-forming tendency. The role of additives in fuel + oxygen systems may be elucidated by labeling either the additive or the fuel. If the additive is an intermediate combustion product, the origin of certain of the other intermediate and final products may be found; some work is described in which the mechanism of formation of certain products has been investigated by addition of [1,3-C^{14}]-acetone to isobutane + oxygen mixtures. Another example of the power of tracer techniques is their use in the determination of the actual rates of formation and consumption of intermediates (as opposed to their net rate of accumulation) even when these two processes occur concurrently, and work is discussed from which it has been possible to calculate the rates of certain elementary reactions occurring during the combustion of paraffins and olefins. Determination of the rates of competing processes has also been effected by the use of fuels and additives labeled with isotopic carbon; measurement of the total isotopic concentrations in the products enables their relative rates of formation from a given labeled intermediate to be determined irrespective of their concurrent production by other routes. Finally, consideration is given to possible further applications of isotopic carbon in combustion research. Author

N63-18517 Cambridge U. (Gt. Brit.)

THE KINETICS OF THE CARBON MONOXIDE FLAME BANDS

M. A. A. Clyne and B. A. Thrush *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 177–183 16 refs (See N63-18501 17-26)

The intensity I_c of the carbon monoxide flame bands observed in the low-temperature reaction of O with CO was found to have similar kinetics to those of the O + NO and H + NO emissions, $I_c = I_{0c}[O]$ [CO], where I_{0c} depended upon the nature but not on the pressure of the carrier gas used as third body I_{0c} and the rate constant k_{1c} for overall combination of O and CO were found to be much less at 293° K than I_{0a} and K_{1a} (the analogous quantities in the O + NO reaction), but while k_{1a} and I_{0a} showed small negative temperature coefficients, I_{0c} was found to have a positive Arrhenius activation energy of +3.7 kcal/mole. Extrapolated values of I_{0a} and I_{0c} at $1/T = 0$ were similar. Most of the excited CO_2 molecules formed in the third-order combination process are quenched collisionally rather than radiatively. The absence of any effect upon the value of I_{0c} when the third body used is in a triplet state (O_2) shows that a spin reversal reaction is not rate determining. The observation of similar pre-exponential factors for I_{0a} and I_{0c} shows that the emission process in the O + CO reaction does not involve spin reversal. It is considered that the flame band emission is due to a transition from an excited single state to the (singlet) ground $^1\Sigma_0^+$ state of CO_2. Molecules in this excited singlet state are formed by a rapid radiationless transition from the triplet state of CO_2 in which they are initially formed. The low value observed for I_{0c} is then due to the presence of an energy barrier in forming the excited triplet and singlet state, and not to the spin-forbidden nature of the overall combination reaction. Author

N63-18518 Hull U. (Gt. Brit.)

THE SELF-INHIBITION OF GASEOUS EXPLOSIONS

R. R. Baldwin, N. S. Corney, P. Doran, L. Mayor, and R. W. Walker *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 184–192 23 refs (See N63-18501 17-26)

(Supported by AFOSR)

In discussing the conditions under which branched-chain reactions, either of the linear branching or quadratic branching type, can give rise to isothermal explosion, it is usually assumed that the initial values of the parameters (e.g. initiation rate, branching factor, termination constants) determine whether the system is stable or explosive. If, however, a reaction product can inhibit the reaction, substantial modification of the explosion condition may result. Two types of mechanism are discussed, one with linear branching and one with quadratic branching, which illustrate this point. In the case of linear branching, it is shown that the original isothermal limit may be modified to a chain-thermal boundary. Thus, whereas ethane, propane, and butane inhibit the second-explosion limit of H_2 and O_2 by direct chain-terminating reactions with H, OH, and O, methane and neopentane can inhibit only via their reaction products (formaldehyde in the case of methane, aldehydes and olefins in the case of neopentane). Such products are formed in significant concentrations only after the uninhibited explosion boundary has been crossed and incipient explosion is developing. A variety of evidence supports the view that the character of the explosion changes from the original isothermal chain-branching explosion to a chain-thermal explosion with

these two hydrocarbons. The second type of inhibiting mechanism, applicable when quadratic branching occurs, is exemplified by the self-inhibition of the H_2/O_2 reaction, as shown by the effect of withdrawal rate on the second limit. Author

N63-18519 Tokyo U. (Japan)
A SHOCK TUBE STUDY OF IGNITION OF METHANE-OXYGEN MIXTURES
T. Asaba, K. Yoneda, N. Kakihara, and T. Hikita *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 193–200 24 refs (See N63-18501 17-26)
(Supported by Japan Educ. Min.)

Ignition of methane-oxygen mixtures was studied by use of the shock tube. Data on ignition delay suggested that two different mechanisms exist, depending upon the methane content; first, for lean mixtures, the branching chain mechanism at relatively low temperatures governs the reaction during the induction period; and second, for rich mixtures, the thermal chain mechanism governs the reaction at high temperatures. For rich mixtures, the controlling reaction is considered to be the second-order reaction between methane and oxygen with an activation energy of about 55 kcal. For lean mixtures, it is suggested the ignition is of the branching chain type and the activation energy is found to be about 21 kcal. In discussing the branching chain mechanism, oxygen atoms are considered to be important chain carriers. As the concentration of methane increases, methane molecules deactive oxygen atoms. This may be the reason why the branching chain reactions do not occur in the rich region. Author

N63-18520 Cambridge U. (Gt. Brit.)
THE NATURE AND CAUSE OF IGNITION OF HYDROGEN AND OXYGEN SENSITIZED BY NITROGEN DIOXIDE
P. G. Ashmore and B. J. Tyler *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 201–209 14 refs (See N63-18501 17-26)

This paper explains the evidence that ignitions in mixtures of hydrogen, oxygen, and nitrogen dioxide are isothermal near some ignition boundaries and thermal near others. It also examines a reaction scheme that can account for the two types of ignition, for the occurrence of ignition limits, and for the induction periods. The ignitions or slow reactions occur after induction periods in which nitrogen dioxide is converted to nitric oxide by a chain reaction with hydrogen. The lengths of the induction periods are fully explained by the kinetics of this reaction. At the end of the induction period there are rapid changes in the NO_2 concentration, leading to ignition or to a slow pressure change. These changes and the changes in the total pressure during this time have been studied in detail. With low sensitizer pressures there is direct evidence of a substantial temperature rise before ignition or slow reaction, supported by indirect evidence obtained by variation of the thermal conductivity, changes of the vessel diameter, and studies of the rate of the slow reaction. In contrast, at higher sensitizer pressures there is little evidence of thermal effects before the onset of the main reaction. The separate experimental studies of the ignitions and of the slow reactions are correlated to give a simple condition determining the position of the limits. The kinetic scheme, based on the branching reactions of the H_2–O_2 system, accounts for the transition from thermal to near isothermal ignitions by a change from quadratic termination by HO_2 linear termination by OH. Author

N63-18525 Leeds U. (Gt. Birt.)
ENERGY TRANSFER FROM HYDROGEN-AIR FLAMES
Roy A. Cookson and John K. Kilham *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 257–263 24 refs (See N63-18501 17-26)

An experimental procedure is devised by which the heat flux is measured in and near the reaction zone of lean hydrogen–air flames, which are burned on a porous disc burner. A conductivity-type heat flow meter is used which has an isothermal sheath surrounding the probe. It is found that, in the region of the reaction zone, the heat flux is much greater than that predicted from ordinary convection alone. Calculations are made by means of a heat-transfer equation, which includes terms for the diffusion and recombination of the various labile species present in the flame. The concentrations of the active species present are calculated from quasi-equilibrium considerations with reference to the amount of OH present in the flame gases. The concentrations of OH, and hence the other species, necessary to produce the high rates of heat transfer measured, are determined and are found to be approximately of the order of the concentrations which have been reported in the literature. The receiving surface of the heat flow meter is treated with catalytic and noncatalytic materials. Since the surface treatment influences the heat flux only to a small extent, the bulk of the recombination appears to take place in the gas phase. Author

N63-18526 California U., Berkeley
ON THE GENERATION OF A SHOCK WAVE BY FLAME IN AN EXPLOSIVE GAS
A. J. Laderman, P. A. Urtiew, and A. K. Oppenheim *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 265–274 10 refs (See N63-18501 17-26)

This paper provides experimental, as well as theoretical, proof that a laminar flame can generate a shock front quite early in the course of its initial acceleration. The flame at this stage of the process is wrinkled laminar, and it propagates at a velocity which is only a few times larger than the normal burning speed. However, no mechanism other than the breakup of the flame front into a cellular structure is necessary for this purpose, nor was it observed. Author

N63-18527 German-French Research Inst., Saint-Louis (France)
SPHERICAL DETONATIONS OF ACETYLENE-OXYGEN-NITROGEN MIXTURES AS A FUNCTION OF NATURE AND STRENGTH OF INITIATION
H. Freiwald and H. W. Koch *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 275–281 14 refs (See N63-18501 17-26)

The spherical detonation of mixtures of acetylene-oxygen-nitrogen was investigated by means of self-luminosity photography and by pressure–time measurements near the detonation. The gaseous mixtures were contained in transparent rubber balloons of different sizes. The detonation was initiated in the balloon center by flame, electric spark, hot wire, exploding wire, or the detonation of a small quantity of lead azide, or mercury fulminate–Tetryl with or without a PETN booster. In addition, a "linear" gaseous detonation in a tube was transformed to a spherical one and was studied as a function of tube diameter and mixture composition. Generally, the detonation region increased with increasing ignition energy. With 7 gm PETN, the spherical detonations of near-stoichiometric rich mixtures were initiated even with 75% nitrogen, e.g., with more nitrogen than is contained in the corresponding fuel–air mixture. With spark ignition, one always observed an ignition delay and a deflagration preceding the spherical detonation. The consecutive shock waves produced by the spherical detonation and by reflections were also investigated. Author

N63-18528 Bureau of Mines. Explosives Research Labs., Pittsburgh, Pa.
DIRECT ELECTRICAL INITIATION OF FREELY EXPANDING GASEOUS DETONATION WAVES
E. L. Litchfield, M. H. Hay, and D. R. Forshey *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 282–286 4 refs (See N63-18501 17-26)
(Contract Nonr 1858(25); Proj. Squid)

Electrical initiation of freely expanding detonation waves has been demonstrated for three gaseous systems. It has been shown that a well-defined minimum stored-energy requirement exists for a given experimental system. Both spark discharges and exploding-wire discharges are discussed as initiation sources, and exploding-wire discharge is shown to produce detonation from smaller stored energies in the systems investigated. In each instance, the existence of a composition, or a range of compositions, requiring discharge of a minimum energy for initiation of freely expanding detonation waves has been established. Typical experimental data have been presented for mixtures of oxygen with the individual fuels ethylene, hydrogen, and propane. The data indicate that initiation of detonation in hydrogen systems requires more energy than in ethylene systems, but less than in propane systems. The pressure dependence of the stored energy required for initiation of detonation is quite complicated; in some instances, the pressure sensitivity is large, and in other instances it disappears. Whenever a marked pressure effect exists, increasing the initial pressure decreases the required initiation energy. Author

N63-18529 Cambridge U. (Gt. Brit.)
THE GROWTH AND DECAY OF HOT SPOTS AND THE RELATION BETWEEN STRUCTURE AND STABILITY
T. Boddington *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 287–293 12 refs (See N63-18501 17-26)

Explosions frequently occur in condensed phase explosives as a consequence of the sudden formation of localized regions of high temperature known as hotspots or temperature spikes. Hotspots may be produced under impact conditions or by irradiation with light, neutrons, and fission fragments, or by the arrival of a shock wave at an impedance discontinuity. In spite of their obvious importance, hotspots have received little theoretical consideration, probably because the relevant equations are rather intractable. This paper deals with two methods of estimating the critical conditions for explosion to occur. The first method involves an approximate analytical approach and has the advantage of demonstrating the relative importance of the numerous parameters involved. The second method, an exact machine solution of the same problem, gives results in good agreement with those derived from the analytical method. Growth to explosion is shown to depend on the magnitude of a single dimensionless criterion. Author

N63-18530 Minnesota Mining and Mfg. Co., St. Paul
A CORRELATION OF IMPACT SENSITIVITIES BY MEANS OF THE HOT SPOT MODEL
Morton H. Friedman *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 294–302 7 refs (See N63-18501 17-26)

It is generally accepted that explosions of most impact-sensitive materials are thermal in origin. The mechanism of impact initiation presumably involves the formation of small regions of high temperature within the reactant. These "hot-spots" may serve as nuclei from which grow the more gross phenomena—decomposition, deflagration, and detonation. The phenomenon of impact explosion may be treated as a two-step process. First, the hot spot in formed in the explosive; second, exothermic reaction within the hotspot leads to sustained deflagration and/or detonation. Exothermic reaction is considered first, and critical hotspot size is determined by computer integration as a function of hotspot and ambient temperatures and the properties of the reactant. It is assumed in the analysis that the sample is infinitely large, heat flow is one-dimensional, reactant consumption and heat losses are negligible, and exothermicity and all physical properties are constant. The validity of the last four assumptions is examined and generally established. The closed form equation for critical hotspot size is applicable when the hotspot temperature is between 400° and 9000° K and when the activation energy for decomposition lies between 5 and 60 kcal/mole. Based on several assumptions regarding the mechanism of hotspot formation, an impact sensitivity correlation is derived, presented graphically, and used to predict the sensitivities of 16 explosives, propellants, and recently synthesized organic compounds. The correlation predicts experimental sensitivities to 40% and indicates the degree to which impact sensitivity is affected by the several thermal and kinetic properties of explosive materials. Author

N63-18531 Naval Ordnance Test Station, China Lake, Calif.
DYNAMIC CHARACTERISTICS OF SOLID PROPELLANT COMBUSTION
M. D. Horton and E. W. Price *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 303–310 14 refs (See N63-18501 17-26)
(Supported by Bureau of Naval Weapons)

The experimentally determined response of a solid propellant combustion zone to normally incident, one-dimensional pressure waves is described. A self-excited, side-vented, tubular burner in which end-burning grains are used is the experimental vehicle. During a firing in this burner, the early growth period of the oscillations and also the decay are exponential with time. The exponential growth and decay constants are used to calculate the acoustical admittance of the combustion zone and these admittances are reported as a function of pressure (200 to 1,600 psi) and frequency (500 to 3,500 cps) for four different propellants. The experimental results are also reported in terms of the fractional increase in energy content of a wave reflecting from a combustion zone. Because the oscillations have exponential growths and decays, observations made during these portions of a firing might be expected to have relevance to a theory, such as that of Hart and McClure, which is mathematically linear. Accordingly, the experimental results are compared in a tentative and general way with this theory and the comparison shows that the experimental admittances are somewhat larger than the theoretical predictions. In the treatment of the experimental data, the mean flow field in the burner is neglected, and the rather questionable assumption is made that the damping of the oscillations in the burner is the same during the decay period (after the propellant is consumed) as it was during the rise. Because of these approximations, the results must be regarded as a little uncertain at this time. Author

N63-18532 Aberdeen Proving Ground. Ballistic Research Labs., Md.
VIRTUAL SPECIFIC ACOUSTIC ADMITTANCE MEASUREMENTS OF BURNING SOLID PROPELLANT SURFACES BY A RESONANT TUBE TECHNIQUE
R. Strittmater, L. Watermeier, and S. Pfaff *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 311–315 7 refs (See N63-18501 17-26)

A resonant tube technique was used to measure the virtual specific acoustic admittance at the surface of a burning solid propellant. Only the real part of the complex admittance is presented because of its importance in determining the acoustic

power generating capacity of a burning propellant. A cast double-base propellant, ARP, was investigated. Results are given in the frequency range from 3500 to 13,500 cps and in the mean chamber pressure range from 310 to 1030 psi. The theory that forms the basis for an analysis of data is given together with approximate working equations. These equations are very accurate in the frequency range in which data are presented. A single longitudinal mode is assumed in the analysis of data. Frequency analysis of taped pressure records shows this to be an acceptable assumption since the harmonic content is small (~4%) for those portions of the records that are used to measure growth and decay rates. The initial web (dimension perpendicular to the burning surface) of the propellant samples was varied. In all cases studied, the web was small compared with the quarter wavelength. Effects of the web dimension on the experimental results are discussed. Author

N63-18533 Aberdeen Proving Ground. Ballistic Research Labs., Md.
AN EXPERIMENTAL STUDY OF THE ALUMINUM ADDITIVE ROLE IN UNSTABLE COMBUSTION OF SOLID ROCKET PROPELLANTS
L. A. Watermeier, W. P. Aungst, and S. P. Pfaff *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 316–327 9 refs (See N63-18501 17-26)

Composite-double base rocket propellant slabs which contained different concentrations and particle sizes of aluminum were burned in a transparent-walled chamber. The chamber was exhausted to the atmosphere. The slabs were ignited in cigarette fashion and burned under ambient nitrogen pressures of 200–900 psi. Experimental runs were made under steady flow conditions and under oscillating conditions with a siren rotating over the exhaust port. Motion pictures were taken of the burning process at high framing rates. Data on droplet burning and concentrations in various regions above the propellant surfaces were obtained from individual frames of the film. The rate of growth and rate of burning or evaporation of the aluminum droplets on the surface and in the flame zone are discussed. Agglomeration of aluminum on the propellant surface was appreciable and was a function of chamber pressure and initial aluminum concentration. As droplets of aluminum left the surface, they vibrated at frequencies near those predicted by the Raleigh assumption for liquid droplets. Concentration measurements did not support the postulation that this process could be a factor in low-frequency combustion instability, however. A low-frequency variation of the measured mass flux of aluminum above the propellant surface was found. It was concluded that this is probably a major contributor to low-frequency phenomena reported in firings of some highly aluminized propellant systems. It also provides a partial explanation for low-frequency luminosity variations reported by some investigators. Author

N63-18534 Utah U., Salt Lake
PARTICIPATION OF THE SOLID PHASE IN THE OSCILLATORY BURNING OF SOLID ROCKET PROPELLANTS
N. W. Ryan, R. L. Coates, and A. D. Baer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 328–334 5 refs (See N63-18501 17-26)
(Contract AF 49(638)-1074; ARPA Order 24-61)

An experimental study of the interaction between the solid and gas phases during oscillatory burning of solid propellants was undertaken with the objective of exploring the validity of the complex theory describing the phenomenon. The apparatus employed was a side-vented, cylindrical vessel with an end-burning propellant grain closely fitted in one end and provision of maintaining the burning zone at a fixed position. Pressure oscillations both at the gas-zone end plate and beneath the grain were recorded. Energy dissipation in the solid propellant, isolated from other losses in the system, was determined from the growth rate constants of the amplitudes of pressure oscillation for grains of varying lengths. The efficiency of acoustical energy or absorption by the grain was found to be maximum when the oscillations are at frequencies close to the natural frequency of the grain. These results confirm the description of oscillatory burning by the acoustical theory in its broad generalizations. Author

N63-18535 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ON THE ANALYSIS OF LINEAR PYROLYSIS EXPERIMENTS
W. Nachbar and F. A. Williams (Harvard U.) *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 345–357 32 refs (See N63-18501 17-26)
(Contract AF 49(638)-412)

Linear pyrolysis experimental data have been used as surface boundary conditions in the analytical treatment of solid-propellant combustion problems. The surface boundary conditions required for the analysis are functional relationships between normal regression velocity, gaseous reactant density, total pressure, temperature, and possibly derivatives of these quantities as well, evaluated at the interface between condensed and gaseous phases during combustion. Available experimental data indicates that a relation based upon equilibrium conditions prevailing at the interface is not generally valid. There are available for many substances, however, hot-plate linear pyrolysis data which give an explicit relation between regression velocity of the condensed phase and a measured hot-plate temperature. This hot-plate temperature has been assumed to be also the temperature at the interface. However, this assumption is thought in some cases to be questionable. In addition, the use of such a rate law in combustion analysis would imply that the total pressure and the gaseous reactant partial pressures or densities, which are greatly different for the pyrolysis test as compared to the combustion, have a negligible effect on the rate. This implication again is questionable. The present paper seeks to answer, in part, these questions on the validity of using linear pyrolysis data. A one-dimensional hot-plate linear pyrolysis experiment is proposed which uses a porous heated plate in place of the present impervious plate. The proposed experiment, having simpler fluid dynamics than present hot-plate experiments, is capable of a reasonably precise analytical description. The analysis is carried out for a general case, and is then specialized to simple and chainlike gasification processes. Author

N63-18536 Aerojet General Corp., Downey, Calif.
DEFLAGRATION CHARACTERISTICS OF AMMONIUM PERCHLORATE AT HIGH PRESSURES
O. R. Irwin, P. K. Salzman, and W. H. Andersen *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 354–365 20 refs (See N63-18501 17-26)
(Contract NOrd 18487)

The deflagration characteristics of pure ammonium perchlorate (AP) strands have been investigated by means of a closed-bomb strand burning technique at pressures from 1000 to 23,000 psi. The data are in general agreement with vented-chamber AP burning-rate data of other investigators at pressures from 1000 to 5000 psi. At pressures above 5000 psi (the pressure limit of previously reported studied), a marked increase in pressure dependence of the linear burning rate occurs. It is postulated that the observed increase in burning rate results from an increased burning surface area, i.e., surface breakup, under the action of the very high pressures existing in the closed bomb. The action of pressure, or stress, upon the burning surface can produce shearing giving rise to increased

burning area by forming new cracks and pores or by enlarging existing cracks and pores. It appears reasonable that the rate at which such cracks can propagate in a material under an applied stress will be determined by the mechanical properties of the material. The crack growth process has therefore been analyzed in terms of a theory, due to Eyring, which relates creep and fracture to fundamental atomic and molecular properties of a material. A geometrical model is presented which considers the accelerated burning process as a development of micro-cracks that form into conically-shaped burning surfaces, the area of which depends upon the pressure. The model is in good agreement with the experimental burning-rate data and with the pressure versus time data for individual burning-rate experiments at pressures above 5000 psi. Author

N63-18537 Imperial Coll. of Science and Tech., London (Gt. Brit.)

A SIMPLE THEORY OF SELF-HEATING AND ITS APPLICATION TO THE SYSTEM AMMONIUM PERCHLORATE AND CUPROUS OXIDE

P. W. M. Jacobs and A. R. Tariq Kureishy *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 366–370 18 refs (See N63-18501 17-26)

The approximations usually made in theories of self-heating are discussed briefly. It is pointed out that kinetic experiments close to the critical ignition state yield results for the fractional decomposition α as a function of time t which depart from the kinetic law applicable at lower temperatures. Nevertheless, these $\alpha(t)$ curves can be analyzed to yield effective rate constants which depend on the temperature of the surrounding (T_0) rather than on the temperature of the reactant (which is, of course, a function of time). A theory of self-heating is developed using these effective rate constants, and this is applied to the calculation of ignition times and self-heating curves. Results are in good agreement with experiment. Author

N63-18538 Tokyo U. (Japan)

AN AEROTHERMOCHEMICAL ANALYSIS OF EROSIVE BURNING OF SOLID PROPELLANT

Hiroshi Tsuji *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 384–393 7 refs (See N63-18501 17-26)

In a solid-propellant rocket of a side-burning type, the flow rate of the hot combustion gases parallel to the burning surface is approximately proportional to the distance from the leading edge of the propellant. In the present paper, therefore, the erosive burning of the solid propellant is analyzed by the boundary-layer approximation in aerothermochemistry for the case where the velocity, $\mu\infty$, of the hot combustion gas stream outside the boundary layer increases linearly with the distance, x, from the leading edge of the propellant, i.e., $\mu\infty = Gx$, and the effects of the hot gas stream on the burning rate of the propellant are examined. Author

N63-18539 Michigan U. Aircraft Propulsion Lab., Ann Arbor

DRAG COEFFICIENTS OF INERT AND BURNING PARTICLES ACCELERATING IN GAS STREAMS

C. T. Crowe (United Tech. Corp.), J. A. Nichols, and R. B. Morrison *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 395–406 21 refs (See N63-18501 17-26)

(NASA Grant NsG-86-60)

The effects of burning and acceleration on the drag coefficients of particles suspended and accelerating in gas streams were studied in a Reynolds number range extending from 250 to 1600. The model chosen for the analytical study was a spherical particle with mass flux through the surface to simulate burning. The governing equation was the integrodifferential representation of the tangential equation of motion of a thin boundary layer on a sphere. The solutions indicated that burning and acceleration tend to reduce the drag coefficient. The fractional reduction was found to be a function of the ratio of mass flux from the surface to that in the free stream *f* for the burning particle and the acceleration modulus Ac for the accelerating particle. The effects of burning and acceleration were studied experimentally by subjecting burning particles (gunpowder) and nonburning particles to the convective flow behind a shock wave in a shock tube. The variation in particle size and displacement with time were obtained by photographing particle shadows with a high-speed framing camera and concentrated light source. The particle density, the shock wave velocity, and the atmospheric conditions, together with the photographic data, provided sufficient information to calculate the particle's drag coefficient. The analytical expressions predicted and experimental results verified that the particle drag coefficient was insensitive to burning and accelerative effects if $Ac \leq 10^{-2}$ and $f < 0.025$. When these conditions are met, other phenomena, such as free stream turbulence, particle rotation, and roughness, can create larger variations in the drag coefficient than the mechanisms considered in this study. Author

N63-18540 Bureau of Mines. Explosives Research Lab., Pittsburgh, Pa.

IGNITION OF MIXTURES OF COAL DUST, METHANE, AND AIR BY HOT LAMINAR NITROGEN JETS

Joseph M. Singer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 407–414 2 refs (See N63-18501 17-26)

Ignition temperatures and limiting fuel concentrations of mixtures of coal dust, methane (fire-damp), and air have been determined by the hot-gas jet ignition method. Ignition promoters and ignition suppressors were also incorporated into the hybrid fixtures and into the hot jet. This study was limited to use of a single coal having about 37-percent volatile matter, ground to about 1 to 5 microns. Hybrid mixtures containing coal dust and air in approximately stoichiometric balance for complete combustion required minimal methane concentrations for ignition at given temperatures. Ignition temperatures and concentrations were decreased by addition of 90 percent CO + 10 percent H_2 to the hot jet. Ignition was inhibited when gaseous halogenated hydrocarbons were added to the hot jet or the hybrid mixture. The inhibiting action of the additives investigated decreased in the following order: bromotrifluoromethane, methyl bromide, carbon dioxide, and water vapor. The observations suggest that ignition suppressors adsorbed on inert dusts, incorporated into water-stemming cartridges, or into the explosive charge itself, will reduce the ignition hazard of detonation products from explosives. Author

N63-18541 General Electric Co. Research Lab., Schenectady, N.Y.

INTRODUCTION [TO] DISCUSSION ON DETONATIONS

Donald R. White *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 415–416 (See N63-18501 17-26)

A general discussion of the structure of detonations and the initiation of detonations in the condensed phase are given. Main highlights are: that the behavior of detonations known as limit phenomena can be regarded as part of the detonation structure problem, that a feature of turbulent detonation structure is the existence of weak shock waves propagating transversely through the reacting mixture behind the primary shock

front, and that the transversely propagating shock waves may be dependent for their continuing existence upon reflection from the shock tube wall in which the experiment is carried out. P.V.E.

N63-18546 Poitiers U. (France)
VIBRATORY PHENOMENA AND INSTABILITY OF SELF-SUSTAINED DETONATIONS IN GASES
N. Manson, C. Brochet, J. Brossard, and Y. Pujol *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 461–469 24 refs (See N63-18501 17-26)

A variation of one of the parameters (chemical composition, pressure, geometry of the container, etc.) of a self-sustained detonation involves a simultaneous modification of its structure (space between the shock wave and the flame) and its stability. However, despite the development of techniques for the observation of the structure and for measurement of the characteristics (velocity, etc.), it has not been possible to give an unambiguous definition of the stability and to specify the interaction between the shock wave and the combustion wave. The purpose of the paper is to examine to what extent it is now possible to characterize: the stability of a self-sustained detonation, according to the results of propagation velocity measurements; the intrinsic instability, with the help of a scale of the vibratory phenomena frequencies; the coupling between the shock wave and the combustion wave, from the behavior of very unstable detonations, the self-sustained propagation of which is accompanied by a complete but momentary separation of the shock and the flame; and the limits of formation of the self-sustained detonations, taking into account some instability parameters. Author

N63-18547 Princeton U., N.J.
OPTICAL STUDIES OF THE STRUCTURE OF GASEOUS DETONATION WAVES
M. L. N. Sastri, L. M. Schwartz, B. F. Myers, Jr., and D. F. Hornig *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 470–473 7 refs (See N63-18501 17-26)

The optical reflectivity method has been applied to the study of the initial stages of detonation waves in hydrogen–oxygen–argon mixtures. Author

N63-18548 General Electric Co. Research Lab., Schenectady, N.Y.
GENERAL DISCUSSION [ON DETONATIONS]
D. R. White et al *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 474–481 14 refs (See N63-18501 17-26)

The instability and structure of detonations in gases and liquids (amplitude density fluctuations, triple shock configurations, acoustic oscillations, thermoneutral induction periods, etc.) are discussed. P.V.E.

N63-18549 Rocketdyne, Canoga Park, Calif.
THE ONSET OF DETONATION IN A DROPLET COMBUSTION FIELD
Frank B. Cramer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 482–487 5 refs (See N63-18501 17-26)
(Contract AF 49(638)417)

A sequence of events has been described which offers an explanation for the processes leading to the onset of detonation in a heterogenous field of low volatility fuel droplets. While the gross pattern appears superficially similar to that occurring in premixed gases, the detailed mechanisms must be explained in terms of the physical behavior of the liquid component of the two-phase system. The pressure ratios and shock velocity relations of both weak and strong shocks in this study fall very close to the values which are calculated for oxygen. That is, the gas phase into which these shocks are being driven is essentially pure oxygen at ambient temperatures. The highest concentration of fuel in this study was 0.20 volume percent. The transport phenomena to produce fuel vapor at a rate sufficient to drive these detonation-like waves at the temperature differentials involved require specific surfaces which are orders of magnitude greater than the original spray presented. A type of mechanical shattering must be available which will produce enough of less than 10-micron droplet mist to provide sufficient fuel vapor to continue to drive the detonation front. The effects of the predetonation, flame-driven flow field controls the time and magnitude of the onset of detonation through droplet shattering these flows impose. Author

N63-18554 Royal Coll. of Science and Tech., Glasgow (Gt. Brit.)
THE INITIATION OF DETONATION IN SOLID EXPLOSIVES
F. J. Warner *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 536–544 10 refs (See N63-18501 17-26)

The problem of transition from deflagration to detonation in a solid crystalline explosive is considered. A mathematical model is set up for a semi-infinite block of explosive, and the partial differential equations resulting from a one-dimensional flow are integrated numerically, using an electronic computer. The explosive is regarded as a homogeneous fluid so far as the hydrodynamic equations are concerned, but as a two-phase solid–gas system for the equation-of-state and equation-of-burning. This leads to the concept of two different temperatures coexisting in the system, solid explosive at one temperature burning to give gaseous detonation products at another temperature some three thousand degrees above the first. The explosive is assumed to exist locally in the form of spheres, and it is assumed that the law of burning involves a pressure term. Initiation is by a shock wave incident on the explosive, and in all the cases investigated, it is found that the transmitted shock wave accelerates or decelerates steadily, and in the results quoted in the paper, the von Neumann spike can be seen building up out of the front of the initiating shock. This is in accord with experimental evidence on solid explosives, but is in sharp contrast with numerical results obtained by other workers and with experimental evidence on liquid explosives. It is believed that the differences are the result of the introduction of the pressure term into the law of burning. Author

N63-18556 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.
RADICAL CONCENTRATIONS AND REACTIONS IN A METHANE-OXYGEN FLAME
R. M. Fristrom *In* Ninth Symp. (Intern) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 560–575 34 refs (See N63-18501 17-26)
(Contract NOw-62-0604-c)

A complete set of characteristic profiles is presented for a spherical methane-oxygen flame [$(CH_4) = 0.078$; $(O_2) = 0.92$; $P = 0.05$ atm]. The intensive properties which are presented as a function of radial distance include measured temperature, derived velocity, measured compositions of all of the stable species, and measured and derived concentrations of the major free-radical species. The new type of information presented is the radical concentrations. Oxygen atoms were measured by a combination of microprobe sampling and chemical scavenging. Hydrogen atom concentrations were derived

from the observed rate of oxygen reaction and confirmed by a preliminary scavenger sampling study. Hydroxyl radical concentrations were derived from the measured rate of carbon dioxide appearance and confirmed by direct measurement using the UV absorption. An upper limit has been set for methyl radical concentrations. These data have been used to test various proposed mechanisms in this flame. Two alternative mechanisms are suggested. For the reaction $OH + CH_4 \rightarrow H_2O + CH_3$, the data suggest an activation energy of 6.5 kilocalories/mole and a frequency factor of 1.4×10^{-14}cc/moles/sec. Author

N63-18557 Leeds U. (Gt. Brit.)
SOME OBSERVATIONS ON THE STRUCTURE OF A SLOW BURNING FLAME SUPPORTED BY THE REACTION BETWEEN HYDROGEN AND OXYGEN AT ATMOSPHERIC PRESSURE
G. Dixon-Lewis and A. Williams *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 576–586 26 refs (See N63-18501 17-26)

The complete analysis of a flame structure consists of studying the variation of the temperature and all the composition parameters with distance y perpendicular to the flame front. By means of such analyses, it is possible to investigate the mechanism and kinetics of the processes controlling the flame. However, for such investigations to have maximum effectiveness, it is necessary to use the simplest flames consistent with the type of reaction mechanism. For this reason, hydrogen–oxygen flames have for some time been studied in this laboratory as comparatively simple flames supported by a branched chain reaction system. The flame studied in this paper has an initial composition of 4.604 percent oxygen, 18.83 percent hydrogen, and 76.56 percent nitrogen. This flame is within the range of hydrogen–oxygen–nitrogen flames which can be stabilized at atmospheric pressure on an Egerton–Powling type of flat flame burner. For a matrix temperature of 336° K, the theoretical flame temperature is 1078° K, and the burning velocity, measured by means of particle track techniques, is 9.2 cm/sec. The flame burns as a flat disc with the reacting gases flowing in a direction normal to the plane of the reaction zone. This produces an approximately one-dimensional flow system, and thus simplifies the analysis. Results of both an experimental and a theoretical investigation of the flame are described. These are combined in an attempt to give information about the flame mechanism. In the theoretical investigation, the effects of alterations in some of the reaction and transport parameters on the flame have also been studied. Author

N63-18558 Imperial Coll. of Science and Technology, London (Gt. Brit.)
THE STUDY OF THE STRUCTURE OF LAMINAR DIFFUSION FLAMES BY OPTICAL METHODS
T. P. Pandya and F. J. Weinberg *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 587–596 18 refs (See N63-18501 17-26)

Progress made in the stabilization of flat diffusion flames and with the establishment of optical methods for the analysis of their structure at velocities up to blowout, is reported. The system has been considered theoretically to allow analysis for rate of heat release and correction for the effect of composition. Considerations of the magnitude of optical path gradients in such flames have led to the adaption of two types of optical method: one based on deflection mapping and the other on interferometry. The results presented include photographs of the flat diffusion flame, records of the distribution of flow velocities, and of refractive index and their interpretation. Author

N63-18559 Cambridge U. (Gt. Brit.)
SOME OBSERVATIONS ON THE MECHANISM OF IONIZATION IN FLAMES CONTAINING HYDROCARBONS
J. A. Green and T. M. Sugden *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 607–621 31 refs (See N63-18501 17-26)
(Supported by General Electric Co.)

Some new results using the mass spectrometric technique for studying positive ions in flames are reported. The great bulk of the ionization found in hydrogen flames is found to arise from traces of hydrocarbon impurity. Most of the work described deals with the ionization induced by addition of small amounts (about 1%) of acetylene to hydrogen–oxygen–nitrogen flames. A distinction between ions formed in the flame itself and those resulting from secondary reactions associated with the sampling system is drawn. The principal mechanism is found to be

$$CH + O \rightarrow CHO^+ + e^- \qquad k_1$$
$$CHO^+ + H_2O \rightarrow CO + H^3O^+ \qquad k_2$$
$$H^3O + e^- \rightarrow H_2O + H \qquad k_3$$

k^3 is found to be $2.3 + 10^{-7}$ cm^3 sec^{-1}, and k_2 to be $7 + 10^{-9}$ cm^{3}sec^{-1}. An estimate of k_1 of $3 + 10^{-12}$ cm^3 sec^{-1} is made. Thermochemical and structural considerations of possible primary ionization reactions are discussed. Author

N63-18560 Cambridge U. (Gt. Brit.)
A CYCLOTRON RESONANCE STUDY OF IONIZATION IN LOW-PRESSURE FLAMES
E. M. Bulewicz and P. J. Padley *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 638–646 24 refs (See N63-18501 17-26)
(Supported by AFOSR)

Electron concentrations and electron–molecule collision cross sections have been measured by the cyclotron resonance method in flames of hydrocarbons, alcohols, esters, ketones, and ethers, all at reduced pressure. The following summarizes the main observations made in the reaction zone: (1) The average electron-flame-gas-molecule collision cross section varies little from fuel to fuel. (2) The electron concentration in hydrocarbon flames is proportional to the total pressure. (3) A plot of the ratio of the electron concentration per molecule of fuel to the total burned flame gas concentration against the number of carbon atoms in the molecule shows the following regularities: points for saturated hydrocarbons lie on a smooth curve; those for unsaturated hydrocarbons lie on various smooth curves displaced upwards to greater ionization levels; if the fuel contains one oxygen atom, the ionization is lowered by an approximately constant amount with respect to the corresponding saturated hydrocarbon; when two oxygen atoms are present, the effect is doubled. (4) The effect of inert additives such as argon, and of nonhydrocarbon fuel additives such as hydrogen was studied. The results are shown to suggest that a very important step in the process of ion production is the reaction $CH + O \rightarrow CHO^+ + e^-$. Polymerization reactions as a means of ion production appear to be of secondary importance. Author

N63-18561 Cambridge U. (Gt. Brit.)
A STUDY OF IONIZATION IN CYANOGEN FLAMES AT REDUCED PRESSURES BY THE CYCLOTRON RESONANCE METHOD
E. M. Bulewicz and P. J. Padley *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 647–658 32 refs (See N63-18501 17-26)
(Supported by AFOSR)

The ionization in the reaction zone of cyanogen–oxygen flames at reduced pressure was studied by the method of cyclotron resonance. Although the temperatures of these flames are sufficiently high for thermal ionization of nitric oxide to account for the observed free electron concentrations, other characteristics of the ionization are consistent only with the operation of nonthermal processes. These processes, however, appear to be different from those inferred to be taking place in hydrocarbon–oxygen flames, and seem to involve energetic three-body reactions. Some auxiliary spectral evidence is also presented. When traces of hydrogen are added, the electron concentration decreases considerably—particularly for fuel-lean flames. As the concentration of cyanogen in the fuel is reduced to about 20 percent, a second ionization maximum appears, associated with a greenish glow from the burned gases. It is shown that attempts to explain this effect simply in terms of reactions occurring in hydrocarbon–oxygen flames meet with difficulties which cannot be resolved at this stage. Author

N63-18566 Atlantic Research Corp., Alexandria, Va.
COMBUSTION STUDIES OF SINGLE ALUMINUM PARTICLES
R. Friedman and A. Maček *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 703–712 12 refs (See N63-18501 17-26)
(Contract Nonr 1858(25); Proj. Squid)

Earlier work of the authors, both experimental and theoretical, on ignition and combustion of single aluminum particles at atmospheric pressure is briefly reviewed, and new experimental data, obtained by two methods, are presented. In the first method, the aluminum particles are injected into the stream of hot gases generated by means of a flat-flame burner. In the second method, the particles are burned in the combustion products of ammonium perchlorate flames with organic fuels added. In both cases, aluminum is burned in an atmosphere of controlled temperature and composition. It is concluded that ignition occurs only upon melting of the oxide layer (m.p., 2300° K) which coats the particle. The process of ignition is not affected by the moisture content of the hot ambient gas and only slightly by its oxygen content. On the other hand, there are distinct effects of oxygen and of water vapor on combustion of the metal. Oxygen promotes vigorous combustion, and, if its concentration is sufficiently high, there is fragmentation of particles. In the virtual absence of water, diffusion and combustion take place freely in the gas phase, whereas in the presence of significant amounts of water, the process is impeded and confined to a small region, because the reactants must diffuse through a condensed oxide layer. Author

N63-18577 Imperial Coll. of Science and Tech., London (Gt. Brit.)
THE ART OF PARTIAL MODELING
D. B. Spalding *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 833–843 24 refs (See N63-18501 17-26)

The strict requirements of similarity theory are shown to be so numerous and restrictive that complete modeling of combustion processes is practically impossible; all successful modeling so far has involved deliberately ignoring many of the similarity rules. The paper reviews some of the more notable examples of this partial modeling, and mentions the physical facts which underlie their success. It is emphasized that every combustion-modeling technique represents a compromise between the requirements of cheapness and reliability. Author

N63-18578 Fire Research Station, Borehamwood (Gt. Brit.)
THE SIZE OF FLAMES FROM NATURAL FIRES
P. H. Thomas *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 844–859 28 refs (See N63-18501 17-26)
(Supported by Dept. of Sci. and Ind. Res., Gt. Brit.)

Uncontrolled fires produce flames where the initial momentum of the fuel is low compared with the momentum produced by buoyancy. The heights of such flames with wood as the fuel are examined and discussed in terms of both a dimensional analysis and the entrainment of air into the turbulent flame. They are then compared with other experiments on the flow of hot gases. Some recent experiments on the effects of wind on such flames are also reported. Author

N63-18579 Agriculture Dept. Sothern Forest Fire Lab., Macon, Ga.
SCALE EFFECTS ON PROPAGATION RATE OF LABORATORY CRIB FIRES
W. L. Fons, H. B. Clements, and P. M. George *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 860–866 13 refs (See N63-18501 17-26)
(Supported by OCD)

This paper presents results of a laboratory-scale propagating flame model in which crib fires are used. The model permits establishment of a steady-state condition for the free burning of solid fuels in the form of wood cribs. The principal objectives are to evaluate quantitatively the effects of the properties of fuel and fuel bed on the many attributes of fire behavior and to establish relationships of the variables in terms of several dimensionless groups. A dimensionless relationship of flame dimensions and modified Froude number is presented for data from a propagating flame model and is in close agreement with findings of other investigators using stationary flame models. Scale effects are also given for the fuel and fuel bed variables on burning time, propagating rate, and burning rate of laboratory crib fires. The work led to the following conclusions: (1) Laboratory crib fires may be used to represent line fires; (2) scaling of fuel size to the 1.5 power for burning time is valid for loosely packed fuel beds; (3) same dimensionless groups may be used for correlation of data from propagating flame models and from stationary flame models. Author

N63-18580 Battelle Memorial Inst., Columbus, Ohio
A MODEL STUDY OF THE INTERACTION OF MULTIPLE TURBULENT DIFFUSION FLAMES
A. A. Putnam and C. F. Speich *In* Ninth Symp. (Intern.) on Combustion., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 867–877 5 refs (See N63-18501 17-26)

This research program has shown that a valid model for studies of mass fires can be produced using multiple jets of gaseous fuels. The basic requirement is that the fuel jets produce turbulent diffusion flames which are buoyancy controlled. A specific operating range where this requirement is met was found for this model. A number of flame arrays have been studied in which the dimensionless groups of (array-flame height/single-flame height), number of jets, source-shape factor, and [flame spacing/(fuel-flow rate)$^{2/5}$] were the important variables. Assuming the flame to be a series of point sources, only (array-flame height/single-flame height) and [flame-spacing/(fuel-flow rate)$^{2/5}$] showed a strong correlation. This correlation is shown to exist both analytically and experimentally, but not to the same extent. The experimental data showed no consistent effect of jet number or flame array. The difference between the analytical and experimental trends is accredited to a mutual aspirating effect of one flame upon another which decreases the effective spacing between the jets.

A good correlation was also obtained, considering the flame as a continuous area fire, between the dimensionless flame height based on the extent of the fire area and the total fuel-flow rate. Author

N63-18583 Rolls Royce Ltd., Derby (Gt. Brit.)
APPLICATION OF THE WATER TRAVERSE TECHNIQUE TO THE DEVELOPMENT OF AN AFTERBURNER
James O. Ellor *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 901–906 5 refs (See N63-18501 17-26)

A technique was developed for assessing the fuel–air ratio distribution of a reheat burner with the engine run at design conditions, but without reheat in operation. Water is injected from the reheat burner fuel manifold, the associated drop in gas temperatures recorded by thermocouples in traverse planes around the burner being a measure of the water–air ratio distribution. Primary interest was in the radial and circumferential spread of the fuel at these planes, and the location of the jet core. By repeating the tests to cover the operational flow range of the burner, the local fuel–air ratio at the stabilizers can be expressed as a percentage of the total fuel–air ratio, at each condition. The extinction limits of the burner having been established with reheat in operation in terms of total fuel–air ratio, the local stability limits of the flame stabilizers can be estimated. However, as the extinction limits generally occur at jet pipe conditions other than those at which the water traverse tests are carried out, appropriate similarity parameters must be used. These are compared quantitatively with the parameters affecting fuel penetration and dispersion in the literature. A correlation has been done of the extinction limits of a series of different reheat burners from flight and test bed results using the water traverse technique. Author

N63-18584 Aeronautical Research Lab., Melbourne (Australia)
SIMILARITY AND SCALE EFFECT IN RAMJET COMBUSTORS
D. G. Stewart and G. C. Quigg *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 907–922 16 refs (See N63-18501 17-26)
(Supported by Dept. of Supply, Australia)

Since "pressure scaling" can be successfully applied to gas turbine and reheat combustors, there is interest in using this technique for ramjets. However, as the fuel distribution process in typical ramjet combustors was suspected of causing scaling difficulties, the present work set out to determine the value of pressure scaling under these circumstances and to establish the appropriate fuel injector scaling criterion. The work was carried out using a current design of practical ramjet combustor in sizes of approximately 3-, 5-, and 8-inch duct diameter. Besides direct scaling comparisons, it was found necessary to investigate the detailed performance of this type of combustor and to study the fuel distribution process, both from isolated injectors and within the actual combustor. An important irregularity of combustor performance noted was the phenomenon of primary fuel penetration into the secondary zone, this giving rise to ahigh sensitivity of performance to fuel distribution effects. The injector scaling conditions necessary to preserve similarity of the penetration process under these circumstances have been determined in the form of an empirical law. Assessment of the comparative performance of the three combustors shows that, under those operating conditions in which the above fuel penetration does not occur, combustion similarity is achieved by pressure scaling, broadly independent of fuel injector size. For conditions in which fuel penetration is marginal, use of the empirical law found for injector scaling results in reasonable similarity. The only scale effect noted has been in the tendency of the primary zone stability limits to decrease in mixture strength as scale increases. This appears to be related to dissimilarity of air flow distribution, an effect which is being further investigated. Author

N63-18586 Imperial College of Science and Technology, London (Gt. Brit.)
EXAMINATION OF THE POSSIBILITY OF PREDICTING REACTION-RATE-CONTROLLED FLAME PHENOMENA BY THE USE OF COLD MODELS
D. Vortmeyer *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 936–948 33 refs (See N63-18501 17-26)

Modeling techniques are applied to combustion processes in high-intensity premixed one-stream combustion chambers. The efficiency and extinction of these systems is regarded as solely determined by the interaction between the gas flow and the chemical reaction. An analog for the simulation of these processes was proposed by D. B. Spalding in 1956. Model and combustion chamber were geometrically similar, and the heat release was simulated by electrically heated coils. It was shown that the model of this type is capable of producing model flames of generally not more than 1° to 2° C above room temperature. The flames behaved similarly to real flames; for instance, they were extinguished once the flow rate exceeded a certain critical value. Do the extinction conditions of these model flames agree with those of real combustion systems? This paper answers this question for cylindrical and rectangular combustion chambers with geometrically simple flameholders in two-dimensional flows. The analog method has been criticized because of the implicit assumption of similarity between flames and isothermal gas flows. For this reason, a part of this paper is devoted to summarizing the results of investigations concerning the question of similarity. Author

N63-18587 Technische Hochschule Hannover (W. Germany)
SEMITHEORETICAL CONSIDERATION ON SCALING LAWS IN FLAME STABILIZATION
Karl-Richard Löblich *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 949–957 16 refs (See N63-18501 17-26)

With good approximation to reality, the stability of flames on flameholders may be described with simple equations for heat and mass transfer. As a result of considerations with regard to a simple model, a dimensionless number N_x is obtained, which is constant in the limiting case of large Reynolds numbers and small blockage ratios for all flameholders and gaseous fuels with a sufficiently high laminar flame speed. It combines the two stabilization laws found by Zukoski and Marble and by Putnam and Jensen, which were discussed further by Spalding. Regarding several deviations from the limit case, we succeeded in finding adaptation functions from theoretical considerations or on an empirical basis. These were introduced into the stability equation, and permit comparison of seemingly very dissimilar systems. A relationship between flame stability and flame flashback is pointed out as affected by transport mechanism and flame speed. In addition, the combustion of heterogeneous mixtures is treated. Author

N63-18590 Rocketdyne, Canoga Park, Calif.
MODELING TECHNIQUES FOR LIQUID PROPELLANT ROCKET COMBUSTION PROCESSES
R. B. Lawhead and L. P. Combs *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 973–981 2 refs (See N63-18501 17-26)
(Contract AF 04(647)-672)

A qualitative, physical-processes description of stable and unstable combustion in rockets is presented to establish the basis for choosing model hardware design criteria. It is concluded that it is not possible to scale rocket combustion processes in the usual sense of the term. The studies conducted at Rocketdyne have shown that model chambers which satisfactorily model the steady-state behavior of large engines must be designed to maintain (1) the propellant injection density, and (2) the chamber-to-throat contraction ratio (hence chamber pressure). For studies of destructive acoustic modes of combustion instability, a third parameter, the frequency, must be maintained. Author

N63-18593 California U., Berkeley
RECIPROCATING ENGINE COMBUSTION RESEARCH – A STATUS REPORT
E. S. Starkman *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1005–1012 147 refs (See N63-18501 17-26)

A status report is presented on the research of combustion control in reciprocating engines. Attention is directed toward knocking and the audible mechanical vibrations associated with rough combustion. Fuel compositions containing tetramethyl lead and fuel injection are investigated as a means of combustion control. C.L.W.

N63-18594 Göttingen U. Inst. of Physical Chemistry (W. Germany)
KNOCK REACTION
W. Jost *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1013–1022 28 refs (See N63-18501 17-26)

Reaction in a rapid compression apparatus was followed by pressure recording, by photography, and by sampling and chemical analysis. It was possible to investigate the highly sensitive hydrogen–oxygen reaction with this equipment. Results obtained with this reaction make it highly improbable that any hot-point effects are present. Detailed results are presented for single- or two-stage ignition of hydrocarbons with air.
Author

N63-18595 California Research Corp., Richmond
ORGANOLEAD ANTIKNOCK AGENTS – THEIR PERFORMANCE AND MODE OF ACTION
W. L. Richardson, P. R. Ryason, G. J. Kautsky, and M. R. Barusch *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1023–1033 17 refs (See N63-18501 17-26)

The effectiveness of various lead alkyls containing one or more methyl groups is compared. The response of many of these additives to lead extenders (agents which generate carboxylic acids in the combustion chamber) is described. A useful theory which explains the antiknock behavior of antidetonants and correlates their response to extenders is discussed. Author

N63-18596 Shell Development Co., Emeryville, Calif.
COMBUSTION OF HYDROCARBONS BEHIND A SHOCK WAVE
C. R. Orr *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1034–1045 11 refs (See N63-18501 17-26)

The combustion of dilute fuel-oxygen mixtures in argon was studied by observing the infrared emissions of reactants, intermediates, and products. The combustion reactions were initiated by the incident shock wave in a simple two-section shock tube. Calibration data obtained on shock-heated samples containing known percentages of product gases do not agree with results from products generated by combustion because chemical reactions can impart considerable energy to the vibrational modes of a molecule. While quantitative calibration was not possible, emission of products formed from combustion presents a fair picture of product concentrations. The rates of formation of products (H_2O, CO, and CO_2) from combustion of ethylene, acetylene, isooctane, *n*-heptane, benzene, and a mixture of hydrogen and CO were compared at two temperatures that were well above their minimum ignition temperature. Complete spectra (in frequency and time) were also obtained from the preflame region for isooctane, *n*-heptane, and benzene and for the entire low temperature flame region for *n*-heptane and benzene. Isooctane and *n*-heptane showed extensive preflame activity. These fuels were completely degraded prior to the flame regardless of the length of the preflame region. The major products were ethylene, higher olefins, and carbonyl. Normal heptane produced acetylene in the flame while isooctane did not. Benzene was only 15 to 20 percent degraded in the preflame region and produced much less intermediate material, aside from CO. Of the hydrocarbons tested, *n*-heptane had the highest rate of combustion as indicated by rate of formation of CO_2 whereas isooctane had the lowest. Production of CO from benzene is considerably slower than from any other fuel. In respect to rate of heat release, as deduced from formation of products, the fuels are aligned in roughly the same order as their performance in reciprocating engines. The lack of correlation between CO and CO_2 emission indicates either that CO_2 may be formed in part by processes that do not involve CO, or that some species other than CO and oxygen is involved and it is a function of the original fuel. Author

N63-18597 St. Andrews U. (Gt. Brit.)
THE KNOCK RATINGS OF FUELS
A. D. Walsh *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1046–1055 16 refs (See N63-18501 17-26)

The purpose of this paper is to try to explain the relative knock ratings of fuels in terms of the chemical-reaction steps that lead to knock. The problem is closely connected with the problems of explaining: (1) why some fuels have a "low" temperature portion of their ignition diagrams and others do not; (2) why some fuels have three lobes in the "low" temperature portions of their ignition diagrams, others have only two and others have only one; (3) why "low" temperature ignition is associated with the occurrence of cool flames; (4) the cause of the so-called "negative temperature coefficient" region observed in the ignition diagrams of most fuels. It is concluded that isomerization of RO_2 radicals (where R is the original fuel molecule minus one H atom) plays an important part in the branching chain process that is needed to explain the formation of cool flames and "low" temperature ignition. The nature and consequences of this isomerization are discussed, and its importance shown to offer some explanation of, *inter alia*: (1) the formation of various products, including dihydroperoxides and β-Dicarbonyls; (2) the knock resistance of cyclohexane and cyclopentane and certain olefins relative to *n*-hexane and *n*-pentane; (3) why methane, alone among the paraffins, possesses no "low" temperature mode of branching and ignition, and therefore has a very high knock rating; (4) the nature of the light emission from cool flames; (5) the decreasing knock resistance of *n*-paraffins with increasing chain length; (6) the occurrence of several lobes in "low" temperature ignition curves, and why certain of these lobes are sometimes missing; (7) the connection of (6) with the knock ratings of branched-chain fuels, and why fuels containing tertiary C-H bonds (which are particularly readily attacked by free radicals) may yet have high knock resistance. Author

N63-18598 Du Pont de Nemours (E.I.) and Co., Wilmington, Del.
EFFECT OF ANTIKNOCKS ON FLAME PROPAGATION IN A SPARK IGNITION ENGINE
S. Curry *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1056–1068 4 refs (See N63-18501 17-26)

Knock is normally accompanied by an acceleration of the primary flame to measured terminal velocities in the range of 300 to 1200 feet per second. The transition to these knock-inducing flame propagation rates can occur over an extended period, and the addition of tetraethyllead results in a significant reduction in the measured flame front velocities under knocking engine conditions. Tetraethyllead does not appear to affect flame propagation rates under nonknocking engine conditions. Acceleration of the knock-inducing flame fronts is believed to result from the formation of some critical concentration of active species produced during the course of the preflame reactions. It thus appears that tetraethyllead suppresses knock by deactivating or inhibiting the formation of these species. The acceleration to knock-inducing flame-propagation rates can begin quite early in the combustion cycle and tetraethyllead can measurably suppress this acceleration. Author

N63-18599 Tokyo U. (Japan)
FLAME STUDIES BY MEANS OF IONIZATION GAP IN A HIGH-SPEED SPARK-IGNITION ENGINE
S. Kumagai and Y. Kudo *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1083–1087 2 refs (See N63-18501 17-26)

The time occupied by combustion in a super-high-speed engine is an extremely important factor. The designation "super-high-speed" will be used here to apply to engines which run at speeds above 10,000 rpm. Higher engine speeds, and resulting smaller size cylinders are favorable factors in increasing the output per unit of displacement volume. This paper describes studies associated with the ignition and combustion phenomena in four-stroke-cycle, small-scale spark-ignition engines in the super-high-speed classification. Author

N63-18600 Rheinisch-Westfälische Technische Hochschule, Aachen (W. Germany)
CLASSIFICATION OF FUELS: THERMODYNAMIC AND REACTION KINETIC PROPERTIES IN OTTO ENGINES
F. A. F. Schmidt *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 1088 (See N63-18501 17-26) Abstract only; reprits available from author

In order to describe fuels in regard to their potential specific performance and to the fuel consumption in Otto engines using different fuels, a new method of calculation is presented, based on an equational compilation of groups of hydrocarbons (paraffins, olefins, etc.), their chemical composition, and heats of combustion. The heat of combustion is divided into the heat of combustion of the elements forming the fuel and the molecular bond energies. Thus, the calorific properties of different fuels can be calculated in a simple manner and a precise relative prediction can be made of the effective performance and the effective fuel comsumption for the operation of an engine with a fuel of arbitrary chemical composition. Furthermore, a potential increase in performance and improvement in fuel consumption can be predicted by a suitable selection of hydrocarbons as fuel components with chemical compositions and molecular bonds. The influence of chemical equilibrium and frozen flow on the performance and the fuel consumption of engines is considered. New comparative results are presented on the chemical reactions in Laval nozzles obtained in this Symposium (problems of frozen flow and equilibrium flow). In order to classify the fuel properties relative to knock, the relation between self-ignition of the fuels and their engine operation are considered theoretically and experimentally. The results obtained in a compression apparatus are the basis for this consideration. A method is described which allows one to determine the laws for every phase of the ignition process by means of the values of the induction period. A method to calculate knock in the engine is presented, which uses the fuel constants of ignition delay. Author

27 PROPULSION

Includes: airbreathing, electric, liquid, nuclear, and solid propulsion.

For related information see: 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

N63-18311 Southwest Research Inst., San Antonio, Tex.
LOX-LUBRICANT IMPACT SENSITIVITY RESULTS FOR ASD COOPERATIVE TEST PROGRAM NO. 3 Special Report [Nov. 1960–Dec. 1962]
B. B. Baber and F. Chang Jan. 25, 1963 66 p 4 refs
(Contract AF 33(616)-7223)
(SRI-RS-369)

Impact sensitivity threshold values of three test samples were evaluated by ten laboratories. Seven laboratories reported results using the ABMA type impact tester, and three laboratories reported results using the RMD impact tester. Even though rather large variations in specific threshold values were reported by laboratories using the ABMA type impact tester, there was general agreement between laboratories with respect to the relative sensitivity of the three test samples evaluated. General agreement of relative sample sensitivity was also obtained by laboratories using the RMD impact tester; however, the order of sample sensitivity was different from that obtained with the ABMA type impact tester. Although the LOX-Lubricant Impact Sensitivity Cooperative Program No. 3 showed definite improvements in test reproducibility from the previous cooperative test programs, further improvement in test reproducibility still appears desireable. Author

N63-18333 Boeing Co. Aero-Space Div., Seattle, Wash.
STUDY ON LARGE LAUNCH VEHICLES UTILIZING SOLID PROPELLANTS Second Progress Review
Nov. 17, 1961 91 p
(NASA Contract NAS8-2438)
(NASA CR-50575; D2-13029) OTS: $8.60 ph, $2.93 mf

This document is a compilation of data presented at the Second Progress Review given to representatives of the George C. Marshall Space Flight Center. The data presented is representative of the approach used in establishing vehicle preliminary designs, overall systems requirements, and development plans for large launch vehicles utilizing solid propellants. A.G.O.

N63-18338 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
PROBE MEASUREMENTS OF THE DISCHARGE IN AN OPERATING ELECTRON BOMBARDMENT ENGINE

William B. Strickfaden and Kenneth L. Geiler Apr. 19, 1963 26 p 8 refs
(NASA Contract NAS7-100)
(NASA CR-50623; JPL-TR-32-417) OTS: $2.60 ph, $0.98 mf

Current-voltage characteristics have been obtained from Langmuir probes at various positions inside a Kaufman-type ion motor. Data are presented for the engine in static (no beam, but plasma) and operating (160-ma beam) conditions. The analysis of the probe data indicates that the electrons in the plasma possess a non-Maxwellian distribution of energies. To obtain plasma properties from the probe curves, the non-Maxwellian energy distribution is assumed to consist of a primary monoenergetic group of high-energy electrons plus the usual Maxwell distribution. Working from this assumption, the probe curves are analyzed for primary and Maxwell energies and densities, and the data for radial positions inside the engine are presented. It is shown from the density curves that the primary electrons are the principal source of ion production. The beam current, as calculated from probe data near the exit grids, agrees to the correct order of magnitude with the measured value. Author

N63-18346 Michigan U. Coll. of Engineering, Ann Arbor
THE FEASIBILITY OF A ROTATING DETONATION WAVE ROCKET MOTOR Quarterly Progress Report No. 3, Dec. 1, 1962-Feb. 28, 1963
G. Olsson et al Mar. 1963 71 p 7 refs
(Contract AF 04(611)-8503); ORA Proj. 05179)
(Rept. 05179-3-P)

The theoretical studies concerning the behavior of detonation waves in heterogeneous liquid-gas media, and the heat transfer mechanism to the wall of a rotating detonation wave engine have been discontinued. The theoretical study of an analytical model for the internal gasdynamics associated with a rotating detonation wave engine has been continued. The experimental studies on all of the phases previously reported have been continued. (1) The undesirable oscillatory nature of the output signal of the Kistler type 601 and 603 pressure transducers has been identified and suppressed. A "Fastax" camera has been utilized to identify the reason for malfunction in the starting sequence of the gaseous 100-lb-thrust motor. It is concluded that initially two detonation waves are formed that move in opposite directions around the anular combustion chamber. All attempts made to eliminate this phenomena have proved unsuccessful up to this time. (2) The experimental determination of the effect of initial temperature and pressure on the detonation velocity is essentially complete. Extensive curves with comparison to data of other investigators is presented. It is concluded that, although the theoretical predictions agree in general with the experimental results of this investigation, they tend to underestimate both the initial temperature and pressure effects on detonation velocities. (3) The experimental setup and procedure for investigating detonations in heterogeneous, liquid-gas media is described. A series of photographs is presented of H_2–O_2 detonation waves passing through a row of water droplets, 1mm in diameter. Indications are that the droplets are severly deformed and break into smaller droplets in the time interval of some 5 to 10 μ-sec after the passage of the wave. It is emphasized that the experiments are of preliminary nature. (4) A test section is described that provides for both the effects of curvature and two-dimensional pressure relief in the radial-inward direction. Schlieren photographs are presented that show the effects of relief on the detonation wave structure. Preliminary results indicate that the velocity of stoichiometric detonation waves is not affected by the combination of curvature and relief provided in the test section utilized. Author

N63-18488 Aerojet-General Corp., Sacramento, Calif.
HIGH CHAMBER PRESSURE OPERATION FOR LAUNCH VEHICLE ENGINES Final Report
L. H. Paytner Apr. 15, 1963 164 p 62 refs
(NASA Contract NAS8-4008)
(NASA CR-50584; Rept. 4008-F-1) OTS: $12.00 ph, $5.12 mf

An analysis of the most appropriate applications of high-pressure launch vehicles has been made. An optimum chamber pressure has been developed for various applications, and the effect of chamber pressure on vehicle performance has been determined. Both LO_2/LH_2 and LO_2/RP-1 systems were considered. The effect of nonideal gas criteria on thermodynamic performance has been compared with ideal gas criteria for pressures up to 10,000 psia, and for simple and complex exhaust gas compositions. The effect of high pressure on combustion stability has been studied theoretically and experimentally. A survey of existing theories of combustion stability has been made. The Princeton University Theory of sensitive time lag vs. interaction index was selected for evaluation of experimental results. A bibliography of pertinent publications in the field of combustion stability is included. Author

N63-18585 Massachusetts Inst. of Tech., Cambridge
MODELING STUDIES OF BAFFLE-TYPE COMBUSTORS
W. P. Jensen (Atlantic Res. Corp.), P. M. R. Burrage, A. C. Tobey (Little (Arthur D.) Inc.), H. C. Hottell, and G. C. Williams *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 923–935 25 refs (See N63-18501 17-26)
(Contracts AF 33(616)-3037 and AF 33(616)-5746)

Geometrically similar ramjet-type combustion chambers of 1.61, 4.026, and 6.065-inch diameter and lengths of 5.25D and 4.25D were operated at Reynolds numbers ranging from 24,000 to 230,000 and ambient pressure levels from 0.2 to 1.5 atmospheres, with propane fuel. Flameholders were annular V-gutters having a leading-edge included angle of 30° and producing 44% blockage of the combustor cross section. Excepting the wall thickness of some burners, all dimensions of burners, flameholders, upstream piping and mixing sections were scaled in proportion to burner inside diameters. Analysis indicated the importance of keeping the following parameters constant if the model experiment was to reproduce prototype performance: (1) Reynolds number, $DU\rho/\mu$. (2) Chemical loading parameter, $k\rho^{n-1}D/U$. (3) Mach number, M U/C. (4) External heat-loss group, $\lambda_G/D[L_w/\lambda_w) + (1/h_{c+r,o})]$. (5) Helmholtz resonator group $(D^3/V)^{1/2}/M$. Analysis indicated the probable importance of group d above—the external heat-loss group—and a poorer performance to be expected of larger burners modeled by use of groups a and b alone, because of abnormally high external loss from large burners. An experimental study of the effect of wall losses, using emissivity control or radiation shielding, confirmed the analysis and explained some of the deviations in burner efficiency results of modeling based on groups a and b alone. This indicated the importance of including group d if the prototype walls run hot. Author

N63-18591 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
THEORETICAL AND EXPERIMENTAL MODELS FOR UNSTABLE ROCKET COMBUSTOR
Richard J. Priem *In* Ninth Symp. (Intern.) on Combust., Cornell U., Ithaca, N.Y., Aug. 27–Sept. 1, 1962 1963 p 982–992 60 refs (See N63-18501 17-26)

The three theoretical models of Damköhler and Penner, Crocco and Cheng, and Priem and Guentert are reviewed. Assumptions involved in each theory are described. The

requirements for modeling combustion instability with each theory are also described. The three theoretical models are compared to show where they differ in their approach and how they solve the equations. Theoretical results obtained from solving the equations are then compared to show how the assumptions in each approach influence the results. Six experimental combustors used to study combustion instability are described. Advantages and disadvantages of each combustor are given. Invariance of the theoretical similarity parameters with respect to full-scale combustors is discussed for each of the experimental combustors. Combustion conditions in full-scale combustors are compared to those assumed for the theoretical models and those encountered in experimental combustors. Author

N63-18653 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
ADDITIONAL STUDIES OF SCREEN AND ACCELERATOR GRIDS FOR ELECTRON-BOMBARDMENT ION THRUSTORS
William R. Kerslake and Eugene V. Pawlik Washington, NASA, Aug. 1963 32 p 12 refs
(NASA TN D-1411) OTS: $1.00

An investigation of accelerator-grid systems was made with three ion thrustors having 5-, 10-, and 20-centimeter-diameter electron-bombardment ion sources. Mercury ion beams of 0.01 to 0.7 ampere were generated at net accelerating voltages of 600 to 7000 volts. Grid geometry was studied to determine the effect of hole shape, spacing, and grid thickness upon the ion focusing of the accelerator system and the fraction of Child's law current passed. Geometric limits for acceptable thrustor performance values are discussed. Grid temperature profiles were obtained to evaluate accelerator warping problems. Graphite grids were tested and found to be a solution to these problems for laboratory testing. The method of calculating thrust from metered electrical parameters was verified with a pendulum-type thrust target. Author

N63-18655 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
NEUTRALIZER TESTS ON A FLIGHT-MODEL ELECTRON-BOMBARDMENT ION THRUSTOR
Robert F. Kemp, J. M. Sellen, Jr. (Space Tech. Labs., Inc.) and Eugene V. Pawlik Washington, NASA, July 1963 38 p 7 refs
(NASA TN D-1773) OTS: $1.00

A series of neutralizer tests on a flight-test-design electron-bombardment thrustor is described that uses a pulsed-beam technique and utilizes a floating beam collector. The thrustor was operated at approximately flight-test design-point power levels. Electric potentials were measured with an electron emissive probe within the plasma exhaust beam for several neutralizer configurations. Measurements were also made of beam current density and neutralizer lifetimes. With a net acceleration voltage of 2500 volts, a net- to total-voltage ratio of 0.56, and a beam current of 200 to 280 milliamperes, the plasma potential was 8 to 9 volts above that of the neutralizer for the original neutralizer configuration, and ranged from this value to 0.9 volt for a number of other configurations. No increase in beam divergence due to inadequate neutralization was detected. Neutralizer lifetimes of 2 to 3 hours were typical, and are adequate for a ballistic flight test. Shielded neutralizer configurations showed projected lifetimes greater than 50 hours. Author

N63-18718 Aerospace Corp. Aerodynamics and Propulsion Research Lab., El Segundo, Calif.
PROPULSION RESEARCH PROGRAM. SUMMARY OF RESEARCH IN THE FIELD OF ADVANCED NUCLEAR PROPULSION Semiannual Technical Report, July 1-Dec. 21, 1961
M. L. Rosenzweig Mar. 10, 1962 65 p 14 refs
(Contract AF 04(647)-930)
(TDR-930(2210-14)TR-1; DCAS-TDR-62-44)

The research program includes both analytical and experimental investigations of single and multiple vortex systems. Experimental apparatus is described. A comparison of the relative performance of the vortex matrix and single-cell vortex is presented, as well as other theoretical and experimental results. Author

N63-18748 Vitro Engineering Co., New York, N.Y.
DESIGN CRITERIA FOR LAUNCHERS AND DEFLECTORS
Mar. 10, 1960 72 p 37 refs
(Contract DA-30-069-ORD-2331)
(Vitro-2331-1-60)

This book presents data useful to the designer of uncooled deflectors for missile launchers. It contains information on the energy content of various propellants, the quantity and form of energy expelled from rocket-engine nozzles, thermodynamic properties of the exhaust striking a deflector surface, selection of the deflector material, and advantages and disadvantages of several deflector designs. Author

28 SPACE RADIATION

Includes: cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts.

For related information see: 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.

N63-18319 Iowa State U., Iowa City
OBSERVATION OF SOLAR COSMIC RAYS FROM OCTOBER 13, 1959 TO FEBRUARY 17, 1961 WITH EXPLORER VII
W. C. Lin and James A. Van Allen [1963] 99 p 54 refs
(NASA Grant NsG-233-62; Contract N9onr-93803)
(NASA CR-50421; SUI 63-15) OTS: $8.60 ph, $3.17 mf

During the sixteen-month period October 13, 1959, to February 17, 1961, twenty-one distinct solar cosmic-ray events were observed with Explorer VII, at high latitudes over North America and Australia in the altitude range 550 to 1100 km. The dates of these events and the approximate absolute peak omnidirectional intensities of protons having $E > 30$ Mev are presented. The latitude dependence of solar cosmic-ray intensity at various longitudes for both Northern and Southern Hemispheres have been studied for eight of the major events which yielded sufficient data for definitive analysis. Such bodies of data are systemized in a coherent manner when plotted against the magnetic shell parameter L of McIlwain. N.E.A.

N63-18414 Armour Research Foundation, Chicago, Ill.
EFFECTS OF SOLAR PLASMA AND ELECTROMAGNETIC RADIATION IN THIN FILMS Final Report, Mar. 15, 1961 to Mar. 14, 1962
Lawrence C. Scholz May 1963 48 p 2 refs
(NASA Contract NASr-29)
(NASA CR-50531; ARF-A188-5) OTS: $4.60ph, $1.64 mf

This is a summary report of work done on sputtering and related phenomena expected for a space vehicle on an interplanetary mission. Preliminary design data for an ultrahigh-vacuum system are given. Sputtering of single and multilayer films is discussed and data are presented. The coloring and bleaching of quartz in the presence of high-energy electrons

and intense ultraviolet radiation are discussed, and preliminary data are presented. Author

N63-18443 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
A STUDY OF RADIATION NEAR THE EARTH AND IN COSMIC SPACE
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 126–142 (See N63-18430 17-32)

A study is made of radiation near the earth and in cosmic space by use of instrumentation aboard a satellite. The measurements of cosmic ray intensity with respect to latitudes are of great interest in view of the fact that they make possible the collection of new data concerning the earth's magnetic field at great distances from the surface of the earth. Data collected indicate that the radiation intensity increases with altitude. This fact indicates that in the zone of polar auroras there occurs an accumulation of charged particles, which oscillate along the lines of force of the magnetic field. The results of measurements of the particle composition of the outer radiation belt support the fact that particles with a path of several g/cm^2 are absent in the outer radiation belt. J.R.C.

N63-18444 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
STUDIES OF INTERPLANETARY GAS USING ION TRAPS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 143–145 (See N63-18430 17-32)

Ionized gas in interplanetary space and in the uppermost layers of the earth's atmosphere is studied using ion traps aboard satellites. The scientific results gained from these studies include the following: (1) the earth is surrounded by a very expansive and highly rarefied atmosphere of ionized gas; (2) in interplanetary space at distances exceeding 22,000 km from the earth's surface, there was no measurable concentration of ionized gas; (3) at distances from the earth's surface from 45,000 to 80,000 km, streams of electrons with energies exceeding 200 ev and with current density $N \sim 10^8$ particles per cm^2 per sec were discovered; and (4) magnetic measurements indicate that in the region of space where the outermost radiation belt is located, there exists a current which distorts the earth's magnetic field. J.R.C.

N63-18460 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CERENKOV-SCINTILLATION COUNTER MEASUREMENTS OF THE LIGHT, MEDIUM, AND HEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION FROM SUNSPOT MINIMUM TO SUNSPOT MAXIMUM
F. B. Mc Donald and W. R. Webber Washington, NASA, July 1963 21 p 31 refs Submitted for Publication
(NASA TN D-1754) OTS: $0.75

The intensity and rigidity spectra of Be, B, C, N, and O have been measured on a series of three Skyhook balloon flights using a Cerenkov-scintillation detector combination. The flights occurred at times close to solar minimum and maximum. The energy and charge resolution is comparable with that obtained by the latest emulsion techniques. It is observed that the light and medium nuclei display the same relative rigidity spectra throughout the solar cycle as the protons and α particles. This conclusion is valid only in the region studied ($E > 400$ Mev/nucleon), and striking variations may be expected for heavy primaries of low energy. The measured ratio of light to medium nuclei at the top of the atmosphere was 0.36 ± 0.06. This was not observed to vary appreciably over the solar cycle. Author

N63-18731 Aro, Inc., Arnold Air Force Station, Tenn.
THE SIMULATION OF HIGH ENERGY PENETRATING RADIATIONS
G. Mac Farlane (RCAF) Arnold Eng. Develop. Center, July 1963 67 p 89 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-118)

The basis of this study has been a search of current literature to determine the penetrating radiation characteristics of the space environments, and to assess the necessity for reproducing such environments completely or in part. This study of the radiation environments led to the formulation of some possible test objectives. The advantages and disadvantages of performing these objectives in the proposed chamber are listed. Two main simulation approaches, one using radiation from isotopic sources and the other using particles generated by high-energy accelerators, are feasible, but only the latter is worthy of consideration, taking into account the size of the vehicles to be tested. Furthermore, only the second method can provide a worthwhile match of the energy and flux spectra of space radiation. Author

N63-18775 California U., Berkeley. Lawrence Radiation Lab.
PROTON ACTIVATION IN SPACE VEHICLES
Paul W. Todd *In its* Biology and Medicine—Semiannual Report, Fall 1962 Dec. 1962 p 1–14 75 refs (See N63-18774 17-16)
OTS: $2.75
(Supported by NASA and AEC)

Proton-induced radioactivity in the inner radiation belt has been analyzed from available experimental data in the literature prior to 1961, to estimate its relevance to spaceflight safety and instrumentation. Proton-excitation functions of carbon, nitrogen, oxygen, and aluminum are presented and used to calculate induced radioactivity in a scintillation detector, an aluminum shell, and in the "standard man." Planetary exploration apparatus is also considered. In these cases, induced radioactivity in the inner radiation belt has been found measurable but small. It presents little problem to spaceflight and exploration, but can give rise to a small increase in count rate if low-background counting is performed by specialized detecting devices. In particular, proton-induced radioactivity was found to influence a detection system designed for the determination of the potassium 40 content of the lunar surface. Author

29 SPACE SCIENCES

Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

For space biology see: 16 Life Sciences.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

N63-18219 National Aeronautics and Space Administration, Washington, D.C.
WE KNOW SO SHAMEFULLY LITTLE ABOUT THE MOON
Howard Simons (Washington Post) Repr. from the Washington Post 8 p
GPO: $0.50

The moon is discussed from the standpoint of origin, and its topography. The dissenting views on lunar dust vs. lava flows in the dark areas of the maria and the volcanic vs. meteoritic origin of the craters are elaborated upon. J.A.J.

N63-18313 National Aeronautics and Space Administration, Washington, D.C.
NASA PROGRAM PLANNING IN SPACE SCIENCES
Dec. 1962 465 p
(NASA TM X-50138) OTS: $23.50 ph, $14.15 mf

The NASA program planning in space sciences is discussed. The following areas are covered: Astronomy, Solar Physics, Planetary Atmospheres, Ionospheres and Radio Physics, Particles and Fields, Planetology, and Biosciences. J.A.J.

N63-18334 RAND Corp., Santa Monica, Calif.
STUDIES OF THE PHYSICAL PROPERTIES OF THE MOON AND PLANETS Quarterly Technical Progress Report (2)
M. H. Davis, comp. and ed. Dec. 31, 1960 66 p 10 refs
(NASA Contract NASw-6; JPL Contract N-33561)
(NASA CR-50576; RM-2711-JPL) OTS: $6.60 ph, $2.18 mf

Among the subjects discussed in this progress report are: the ultraviolet spectrometer for the Mariner A, general circulation of the planetary atmospheres, the interpretation of radiometric measurements of Venus, atmospheric reentry (Mars vs. Venus), density of the very high atmosphere, and orbit determinations from terminator observations. J.A.J.

N63-18340 California Inst. of Tech. Div. of Geological Sciences, Pasadena
VENUS: A MAP OF ITS BRIGHTNESS TEMPERATURE
Bruce C. Murray, Robert L. Wildey, and James A. Westphal Repr. from Science, v. 140, no. 3565, Apr. 26, 1963 p 391–392 refs
(NASA Grant NsG-56-60; NSF Grant 25210)
(NASA CR-50464)

The 200-inch Hale telescope has been used to make high-resolution maps of the brightness temperature of Venus at wavelengths 8 to 14 microns. Resolution of about 1/30 of the disk reveals a general symmetry about the plane of the orbit, no day–night temperature effects, and a transient temperature anomaly in the Southern Hemisphere. Author

N63-18384 RAND Corp., Santa Monica, Calif.
FLIGHT REGIMES IN THE ATMOSPHERES OF VENUS AND MARS
Peter P. Wegener July 1963 55 p 41 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3388-PR)

Preliminary estimates of the flight parameters to be encountered on Mars and Venus are desirable. Although considerable qualitative information on the two planets is available, there are few quantitative data that contribute to an understanding of their atmospheres. From the available quantitative data, limiting models of the two atmospheres have been constructed, and from these models it has been possible to estimate the approximate extremes of aerodynamic parameters likely to be encountered. It is seen that the uncertainties in aerodynamic flight conditions encompass orders of magnitude, particularly at high altitudes. Author

N63-18415 Stanford Research Inst., Menlo Park, Calif.
FEASIBILITY OF REMOTE COMPOSITIONAL MAPPING OF THE LUNAR SURFACE. EFFECTS OF SURFACE ROUGHNESS
Eugene A. Burns (Space Technol. Labs.) and R. J. P. Lyon May 23, 1963 24 p 17 refs
(NASA Contract NASr-49(04))
(NASA CR-50544) OTS: $2.60 ph, $0.92 mf

Consideration of an instrument capable of remote compositional mapping of the lunar surface by measurement of the diagnostic spectral emissivity curves results in the recommendation of a modified Perkin–Elmer Model SG-4 Spectrophotometer. A discussion of the constraints imposed on the design of this instrument for spectral resolution, weight, signal-to-noise ratio, detector temperature and configuration, and power requirements is presented, together with the implications of these factors on the objectives of compositional mapping from a spacecraft. Author

N63-18422 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
LUNAR SURFACE AND SUBSURFACE MAGNETIC SUSCEPTIBILITY INSTRUMENTATION
Edgar M. Bollin [1962] 7 p Repr. from IRE Trans. Instr., v. I-11, nos. 3 & 4, Dec. 1962 p 101–106 4 refs Presented at the 1962 International Conf. on Precision Electromagnetic Measurements
(NASA Contract NAS7-100)
(NASA CR-50578; Conf. Paper 1.5; JPL TR-32-343)

Multicoil induction measurements of the lunar surface and subsurface magnetic susceptibility are under study. Major considerations are the improvement of the accuracy and logging ability of various probe configurations. Special boundary conditions of high vacuum, extreme ambient temperature variation, restriction to mechanically passive systems, simple electronics, low power and light weight all contribute to degradation of the accuracy of the instrument. Measurements in the range of 10 to 100,000 micro-oersted/gauss are of interest. Nonsedimentary rocks range from 40 to 1000 μ-oersted/gauss, and the presence of nickel–iron meteoritic material may extend the range beyond the present limits of measurement. The determination of the presence or absence of meteoritic material is necessary to validate not only the accuracy of the susceptibility measurement, but also the accuracy of low-level magnetometer measurements. Author

N63-18431 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
SPECIAL FEATURES OF THE MOTION OF SATELLITES
S. G. Aleksandrov and R. Ye Federov *In its* Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 1–17 1 ref (See N63-18430 17-32)

A study is made of the motion of satellites, with particular interest given to the orientation of the satellite in space. The motion of a satellite about an orbit can be characterized by six elements: the inclination of the orbit, the right ascension of the ascending node, the semimajor axis of the orbit, its eccentricity, the argument of the perigee, and the passage time of a satellite through the ascending node. However, in actuality, the motion of an earth satellite is influenced by a number of additional factors, which include: atmospheric drag, the difference of the earth's gravitational field, and effect of the solar and lunar gravitational field. The motion of the satellite with respect to the earth is the result of the aggregate of its orbital motion, the diurnal rotation of the earth, and the precession of the orbit's plane. When analyzing the motion of a satellite in orbit, it is frequently necessary to know its orientation, since, with an elongated shape of the satellite, the coefficient of aerodynamic drag substantially depends on its orientation relative to the velocity vector. J.R.C.

N63-18432 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
PECULIARITIES OF MOTION OF SPACE VEHICLES IN THE SOLAR SYSTEM. FLIGHTS TO THE MOON, MARS AND VENUS. MAN-MADE PLANETS
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 18–36 (See N63-18430 17-32)

The motion of space vehicles in the solar system flights to the Moon, Mars, and Venus is studied. The aspects of motion investigated include: the dependence of the angle of inclination of the velocity vector upon the range angle; duration of flight of spacecraft to the moon; the dependence of the velocity of a space vehicle at the boundary of earth's sphere of influence upon its velocity at the end of the ejection phase; distance from the sun to the perihelion of the orbit at various velocities at the end of the ejection phase; values of the minimum velocities for flights to the planets; orbits of flights to Mars; values of total velocity necessary for ejection of space vehicle into circular orbit about the sun; and orbits of flights to Venus. J.R.C.

N63-18433 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
REQUIREMENTS ON THE ACCURACY OF THE MOTION PARAMETERS AT THE END OF THE EJECTION PHASE
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 37–40 1 ref (See N63-18430 17-32)

The requirements on the accuracy of the motion parameters at the end of the ejection phase are investigated. An error in the ejection angle always results in a decrease of the perigee height and a corresponding increase of the apogee height. Since satellite deceleration occurs mainly near the perigee, this results in decreased satellite lifetime. It is shown that when a rocket is launched toward the moon, the velocity error at the end of the ejection phase should not exceed several meters per second, while the velocity vector should not deviate by more than 0.1° from its calculated direction. Greater influence is exerted by orbital ejection errors when launching space vehicles to other planets. For flight to Mars on an elliptical orbit which assures approach to Mars at its aphelion, a velocity error at the end of the ejection phase of 1 m/sec causes a deviation of the order of 30,000 km in the orbit of the vehicle near Mars. Therefore, for such flights the movement of the vehicle should be corrected in flight. J.R.C.

N63-18456 Northrop Corp., Nortronics Div., Hawthorne, Calif.
RETROTHRUST PROFILE ANALYSIS FOR LUNAR LANDING
W. F. Hall, C. F. Rodriguez, and J. Schildkraut Mar. 1962 174 p
(NORT-62-21)

A method for evaluation of the errors accumulated during the retrothrust portion of the flight of a vehicle landing on the moon is given. The analysis is based on a single retrothrust operator using a constant thrust engine and deals with the basic path characteristics during retrothrust. Special expressions are developed for terminal velocity and path length; and an optimum thrust condition is explained and used to derive simplified terminal expressions. Expressions for the retrothrust error coefficients, which result from basic independent uncertainties involved in the retroengine, are developed. The coefficients are expressed in terms of the terminal errors and are developed for each of three methods of thrust termination (fuel burnout, velocity cutoff, and time cutoff). Using the optimum thrust condition for the nominal trajectory, it is shown that error coefficients for nonvertical trajectories are simple sine or cosine functions of the initial trajectory angle. Criteria are given so that probable impact velocity for a hard landing system and the vernier engine impulse requirement for a soft landing system can be determined. P.V.E.

N63-18685 National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N. Y.
THE ORIGIN OF ATMOSPHERIC XENON
A. G. W. Cameron Repr. from Icarus, v. 1, no. 4, Jan. 1963 p 314-316 7 refs see N63-12595 06-29

Part of the differences in isotopic composition of atmospheric and meteoritic xenon can be attributed to irradiation of solar xenon by neutrons during the deuterium-burning phase of solar contraction, followed by accretion of the irradiated xenon into the atmosphere. This problem is examined here more carefully following a new measurement of the reaction rate for capture of protons by deuterium by Griffiths, Lal, and Scorfe. It is concluded that the majority of atmospheric xenon, apart from that produced by the decay of extinct radioactivities, was once in the sun during the deuterium-burning phase.
Author

N63-18688 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
STUDIES IN THE FIELDS OF SPACE FLIGHT AND GUIDANCE THEORY Progress Report No. 2, Dec. 1, 1961 to June 15, 1962
June 26, 1962 276 p 135 refs
(NASA TM X-50186; MTP-AERO-62-52) OTS: $17.50 ph, $7.48 mf

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11. EXISTENCE OF MULTIVARIABLE LEAST SQUARES APPROXIMATING POLYNOMIALS D. F. Dupree (Northeast La. State Coll.) p 261–272 (See N63-18699 17-20)

12. ANALYTIC DIFFERENTIATION BY COMPUTER APPLIED TO THE "FLAT EARTH" PROBLEM J. W. Hanson (North Carolina U.) p 273–276 2 refs (See N63-18700 17-20)

N63-18689 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
STUDIES IN THE FIELDS OF SPACE FLIGHT AND GUIDANCE THEORY. INTRODUCTORY AND SUMMARY
W. E. Miner *In its* Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 1–4 (See N63-18688 17-29)

This paper contains progress reports of NASA-sponsored studies in the areas of spaceflight theory and guidance theory. The studies are carried on by several universities and industrial companies. This progress report covers the period from December 1, 1961 to June 15, 1962. Author

N63-18690 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
THREE-DIMENSIONAL LOW-THRUST INTERPLANETARY TRAJECTORY OPTIMIZATION
Hans K. Hinz and H. Gardner Moyer *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 5–43 4 refs (See N63-18688 17-29)

A successive approximation technique has been used to compute three-dimensional optimal low-thrust interplanetary trajectories. For this purpose, two IBM-7090 computer programs have been developed—one for constant thrust applications, and the other for variable thrust problems. The computer programs generate and store the planetary ephemeris, and automatically optimize the trajectories for missions such as rendezvous and intercept. The "penalty function" technique is used to handle constraints on the position and velocity components and the fuel weight at the terminal point. Optimum low-thrust Earth-to-Mars rendezvous and intercept trajectories have been numerically computed for two synodic periods from January 1965 to July 1969. Initial results, when compared with previous coplanar studies, indicate that there are no highly significant differences between two- and three-dimensional optimum low-thrust interplanetary trajectories. This tentative conclusion, based upon limited results, should not be generally accepted until additional numerical studies are carried out. The result appears to be associated with the small (1.85 degree) inclination of Mars' orbit to the ecliptic. Author

N63-18691 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
A REFERENCE SOLUTION FOR LOW-THRUST TRAJECTORIES
Gordon Pinkham *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 44–51 (See N63-18688 17-29)

This report presents an analytical solution to the trajectory equations for a low-thrust rocket when the thrust is tangential and varies nearly inversely with the square of the radius from the central body. The variation in the thrust magnitude has been so chosen that the solution possesses as many arbitrary constants as the order of the system of differential equations governing the motion. Thus an Encke or variation-of-parameters analysis of neighboring trajectories is practicable.
Author

N63-18692 Grumman Aircraft Engineering Corp., Bethpage, N.Y.
OPTIMAL LOW-THRUST NEAR-CIRCULAR ORBITAL TRANSFER
Hans K. Hinz *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 52–73 3 refs (See N63-18688 17-29)

Optimum low-thrust transfers between neighboring circular orbits have been studied for a simplified system model. Small deviation from an original circular orbit motion are assumed, and the thrust acceleration is taken to be constant. Within the limits of these assumptions, the numerical results are sufficient to describe, in general, the optimum thrust steering program and performance capability of a vehicle in terms of its thrust/weight ratio, orbital frequency, and thrust duration. For values of thrust duration equal to an integral multiple of the orbital period, the optimum thrust direction is continuously circumferential. Author

N63-18693 General Electric Co. Space Sciences Lab., Philadelphia, Pa.
THE CALCULUS OF VARIATIONS APPROACH TO CONTROL OPTIMIZATION Special Report No. 1
Carlos R. Cavoti June 15, 1962 *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 75–168 27 refs (See N63-18688 17-29)
(NASA Contract NAS8-2600)

The present work is an attempt to present a general unified study of the first necessary conditions for an optimum trajectory, with special emphasis on the geometrical interpretation of some of these conditions. In this study, the pertinent necessary conditions are derived in a simple manner, although trying to preserve the necessary rigorousness of formulation. The introduction of the generalized canonical transformation presented is shown to be of importance in deriving the "Maximality Principle" and graphically interpreting this principle and other necessary conditions. The corner point conditions are also analyzed and their geometrical interpretation is included. The author is suggesting the application of interesting numerical-geometrical techniques of analysis for the treatment of complicated problems in trajectory optimization studies. In the study presented here the derivations usually available in the literature on the Calculus of Variations for problems of the Lagrangian form are now performed for a generalized Mayer formulation, which accounts for the occurrence of control variables in the side conditions, the latter being assumed of a general form. Author

N63-18694 Republic Aviation Corp., Farmingdale, N.Y.
THE HAMILTON-JACOBI FORMULATION OF THE RESTRICTED THREE BODY PROBLEM IN TERMS OF THE TWO FIXED CENTER PROBLEM
Mary Payne and Samuel Pines *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 169–205 13 refs (See N63-18688 17-29)

This report contains a development of the classical Hamilton–Jacobi perturbation techniques, applying the known solution of the Two Fixed Center Problem to the Restricted Three Body Problem. Author

N63-18695 Kentucky U., Lexington
THE RESTRICTED THREE BODY PROBLEM. 1. THE SURFACES OF ZERO VELOCITY IN REGULARIZED COORDINATES. 2. THE EULER PROBLEM BY GRAPHICAL ANALYSIS
W. S. Krogdahl, T. J. Pignani, J. B. Wells, and J. C. Eaves *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 207–223 3 refs (See N63-18688 17-29)

Representative zero-velocity curves for the restricted three-body problem have been calculated in bipolar and closely related regularized Thiele coordinates. Attention has also been given to a study of the Euler problem, through a graphical analysis, as a preliminary approach to the study of this problem, by the use of the Weierstrass P-functions. Author

N63-18696 Chrysler Corp. Missile Div., Detroit, Mich.
NUMERICAL APPROXIMATION OF MULTIVARIATE FUNCTIONS APPLIED TO THE ADAPTIVE GUIDANCE MODE
R. J. Vance *In* NASA. Marshall Space Flight Center, Huntsville, Ala. Studies in the Fields of Space Flight and Guidance Theory June 26, 1962 p 225–249 80 refs (See N63-18688 17-29)

A system of orthonormal polynomials for approximating two control functions is described. Properties that are useful in formulating computational methods are also given. Theorems of functional analysis that are relevant to the selection of data points are stated. Author

30 SPACE VEHICLES

Includes: launch vehicle—spacecraft combinations; operating problems; and stability and control.

For manned space capsules, satellites, and space probes see: 32 Space Vehicles (Spacecraft).

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For related information see: 04 Aircraft; 08 Communication; and 22 Navigation and Guidance.

N63-18248 Bell Aerosystems Co., Buffalo, N.Y.
INVESTIGATION OF ACTIVE COOLING STRUCTURAL CONCEPTS FOR SUPERORBITAL REENTRY, PART I Report
J. A. Dickson, R. O. Brigham, and A. L. Mistretta Nov. 1962 127 p 6 refs
(Contract AF 33(657)-8386)

Progress is reported of a test program to develop active cooling structural concepts for superorbital reentry. The Haynes 25 specimens which will be used to measure vapor heat-transfer coefficients are completed and instrumented. The columbium-1% zirconium test specimens were designed and partially fabricated. The liquid metal loop is nearing completion, after which it will be shipped to the test site for checkout. The induction heating system is ready for checkout in conjunction with the liquid metal and instrumentation systems. The work coils are being completed on schedule. The analytical and design studies have been started. N.E.A.

N63-18341 National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex.
HABITABILITY IN SPACE STATIONS
Stanley C. White and John H. Reed, Jr. N.Y., Am. Inst. of Aeron. and Astronautics [1963] 5 p Presented at the AIAA/ASMA Manned Space Lab. Conf., Los Angeles, May 2, 1963 (AIAA Paper 63-138) AIAA: $0.50 members, $1.00 nonmembers

Habitability is summarized as the resultant state accomplished through the interaction of all of the provisions furnished to aid the men in the achievement of a successful mission while in a hostile environment. The need for a dynamic review for the accomplishment of habitability during all phases of the design, development, and flight programs is discussed. Author

N63-18405 National Aeronautics and Space Administration, Washington, D.C.
CHRONOLOGY OF MAJOR NASA LAUNCHINGS Historical Report No. 8 Oct. 1, 1958–Dec. 31, 1962
NASA. Office of Educational Programs and Services Jan. 1963 13 p
(NASA TM X-50133) OTS: $1.60 ph, $0.80 mf

A chronology of major NASA launchings, October 1, 1958, through December 31, 1962, is presented. The general mission, launch vehicle, vehicle performance, payload performance, and mission results are presented. J.A.J.

N63-18601 National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
PROCEEDINGS OF THE NIMBUS PROGRAM REVIEW [HELD AT VALLEY FORGE, PA.] NOVEMBER 14–16, 1962
Harry Press et al [1962] 405 p 11 refs
(NASA TM X-50151; NASA X-650-62-226) OTS: $22.50 ph, $12.35 mf

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21. NIMBUS INTEGRATION AND TEST PROGRAM PLAN J. F. Mc Guckin (GE), and J. V. Michaels 20 p (See N63-18622 17-30)

N63-18602 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INTRODUCTION TO NIMBUS
W. G. Stroud *In its* Proc. of the Nimbus Program Review [1962] 3 p (See N63-18601 17-32)
(Paper 1)

An introduction to the Nimbus Project and the objectives of it are reviewed. Papers presented are intended to give the participants in the Nimbus project, who are working on individual parts of the system, an opportunity to become familiar with the whole system. Emphasis is placed on the spacecraft systems (i.e., launch vehicle, spacecraft, data acquisition, or data utilization), tests, and performance. N.E.A.

N63-18603 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE NIMBUS PROJECT – ORGANIZATION, PLAN, AND STATUS
Harry Press *In its* Proc. of the Nimbus Program Review [1962] 20 p (See N63-18601 17-32)
(Paper 2)

Objectives and scope of the Nimbus project, project organization, summary of project accomplishments, and present status and future plans are discussed. N.E.A.

N63-18604 Weather Bureau, Washington, D.C.
METEOROLOGICAL APPLICATIONS OF NIMBUS DATA
E. G. Albert *In* NASA. Goddard Space Flight Center, Greenbelt, Md. Proc. of the Nimbus Program Review [1962] 29 p 11 refs (See N63-18601 17-32)
(Paper 3)

Some specific applications of the Nimbus system in solving meteorological observation problems are the identification and positioning of major weather systems. Also, meteorological conditions at the earth's surface, including the delineation of ice packs and mapping of snow fields, are applicable to the Nimbus system. Radiation data may be used to determine the earth's heat balance and local heat anomalies. Complete surveillance of the entire globe on a daily basis is contemplated with Nimbus. The basic television and radiometer meteorological data provided by Nimbus will be presented to the ultimate user in three basic formats: (1) gridded analog pictures; (2) digital computer summaries, in a format suitable for use by computational facilities; and (3) a computer-prepared-map-scale rectification which will be professionally interpreted and annotated. Nimbus data received at the CDA (command and data acquisition) station and appropriately processed are transmitted to the National Weather Satellite Center where the meteorologically useful Nimbus data presentations are prepared, compared with conventional data, annotated by professional meteorologists, and presented to the responsible forecasting agencies. N.E.A.

N63-18605 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS SPACECRAFT SYSTEM CONCEPT
R. Stampfl *In its* Proc. of the Nimbus Program Review [1962] 17 p (See N63-18601 17-32)
(Paper 4)

An attempt is made to explain the design concept of the Nimbus system. Discussed are (1) Nimbus mechanical and structural design; (2) the Nimbus high-noon retrograde orbit; (3) Nimbus constraints; (4) Nimbus television coverage; and (5) Nimbus data-acquisition ground-receiving equipment. N.E.A.

N63-18606 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS SPACECRAFT SYSTEM DEVELOPMENT
J. V. Michaels *In its* Proc. of the Nimbus Program Review [1962] 19 p (See N63-18601 17-32)

This report describes how the original Nimbus concept developed into the realizable spacecraft system. Special features of the spacecraft and the sensory ring contents are described. The spacecraft developmental plan, with stress on the special nature of the approach; the government responsibility for system design and management; and the role of the spacecraft and subsystem contractors in evolving the development are discussed. N.E.A.

N63-18607 General Electric Co. Missiles and Space Div., Evendale, Ohio
STATUS OF THE NIMBUS INTEGRATION AND TEST PROGRAM
L. Michelson *In* NASA. Goddard Space Flight Center, Greenbelt, Md. Proc. of the Nimbus Program Review [1962] 18 p (See N63-18601 17-32)
(Paper 6)

Status of the Nimbus integration and test program is discussed. Also, General Electric's role and responsibilities in the Nimbus project are discussed. Basic spacecraft structural-hardware and electrical operating components are essentially completed. Models of the spacecraft have been built to corroborate various analyses. Tests of the flight adapter have been successfully completed. The extensive test facilities required for the Nimbus project are essentially completed. The responsibilities of the manager of systems design and evaluation, the manager of spacecraft design and engineering, the manager of NIMIT programing, and the manager of operational systems are described. N.E.A.

N63-18608 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS GROUND SYSTEM
L. Stelter *In its* Proc. of the Nimbus Program Review [1962] 20 p (See N63-18601 17-32)

The Nimbus ground system consists of two command and data-acquisition (CDA) stations, one being established in Alaska and the other in eastern Canada. Each of these stations contains two major elements, the antenna system and the Nimbus unique equipment. The antenna system includes an 85-ft-diameter parabolic antenna, its tracking and pointing systems, telemetry receivers, command transmitters, and command antennas. The Nimbus unique equipment includes a clock/command subsystem, equipment required for processing PCM telemetry data received from the spacecraft, equipment for processing the TV and IR data received from the spacecraft, and computers for additional data processing. Wideband communication circuits are required to transmit the meteorological data received at the CDA stations to the Nimbus Technical Control Center. The current status of the Nimbus Ground system is presented. N.E.A.

N63-18609 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STABILIZATION AND CONTROL SUBSYSTEM
J. F. Turtil (GE) and K. Hoepfner *In its* Proc. of the Nimbus Program Review [1962] 24 p (See N63-18601 17-32)
(Paper 8)

Stabilization and control by means of an altitude control subsystem are described for the yaw, roll, and pitch axis of the Nimbus satellite. In the general aspects of launch and stabilization sequence, stabilization of the satellite begins after separation from the Agena second booster stage. The stabilization

sequence indicates the use of four control loops: pitch, roll, and yaw, for control of system altitude, and the solar-array position loop for control of the solar paddles. These four loops compose the essential control aspects of the control subsystem. Two additional functional aspects of the control subsystem pertain to telemetry outputs and to provisions for implementing ground commands which are received by the Nimbus spacecraft and then passed on to the control subsystem. Difficulties encountered in the Nimbus control subsystem and three-axis testing of the subsystem are discussed. N.E.A.

N63-18610 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STRUCTURAL CONCEPTS IN NIMBUS SPACECRAFT DESIGN
A. F. White, Jr., and M. B. Weinreb *In its* Proc. of the Nimbus Program Review [1962] 11 p (See N63-18601 17-32)
(Paper 9)

In the concepts and design objectives of the Nimbus program, system flexibility—the planning of various missions over an extended period of time—was the prime concept in the mechanical design of the Nimbus spacecraft. Therefore, the objective was to make each system as independent as possible in the mechanical design and to have the design itself contribute to the desired thermal and electrical independence. The design treats the spacecraft as three major elements: controls, solar array, and sensory section. Each element is mechanically and thermally independent, with the exception of structural interfaces. The design had to be sufficiently flexible to permit many tradeoffs in order to obtain optimum conditions for the entire spacecraft system. N.E.A.

N63-18611 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DEVELOPMENT OF THE NIMBUS STRUCTURE
E. O. Stengard *In its* Proc. of the Nimbus Program Review [1962] 15 p (See N63-18601 17-32)
(Paper 10)

This paper describes the differences between the initial concept and the present Nimbus structural design, as well as major problems arising during its development. N.E.A.

N63-18612 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THERMAL CONTROL OF THE NIMBUS SPACECRAFT
F. Drummond (GE) and P. Crossfield *In its* Proc. of the Nimbus Program Review [1962] 19 p (See N63-18601 17-32)
(Paper 11)

The Nimbus design uses both active and passive control to achieve a thermal environment in which the sensors and experiments will perform, with a minimum of degradation, for the 6-month spacecraft life. The sensory assembly, the control assembly, and the solar platforms, the three main assemblies of the spacecraft, have thermal control. Requirements governing the thermal design and tests for proving the design are presented. The Nimbus, as presently designed, carries about 30 pounds of thermal-control material and equipment. Conversion of any of this weight to productive sensor or experiment capacity, by maximizing component subsystem and design, can serve to increase the effectiveness of the Nimbus program. N.E.A.

N63-18613 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SPECIAL ASPECTS OF NIMBUS SPACE CRAFT INTEGRATION
R. Di Girolamo (GE) and J. P. Strong, Jr. *In its* Proc. of the Nimbus Program Review [1962] 18 p (See N63-18601 17-32)
(Paper 12)

Some of the efforts involved in integrating a group of electrical and mechanical Nimbus subsystems into a unified, operational spacecraft are described. Major tasks to be covered are the module location in the sensory ring, wiring assemblies, vibration requirements, operational commands, antenna design, unfolding of the solar paddles, electrical load simulation, telemetry conversion, the beacon killer, and test programing. N.E.A.

N63-18614 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS SOLAR POWER SUPPLY
M. B. Weinreb and C. Mac Kenzie *In its* Proc. of the Nimbus Program Review [1962] 21 p (See N63-18601 17-32)
(Paper 13)

This paper describes the complete Nimbus solar power-supply subsystem, problems encountered in its development (storage and regulation assembly), system operation, and its current status. The solar-conversion power supply consists of a solar array, used to convert the sun's energy into electrical power, and the electronic equipment required to store and convert the power into the form needed by the other Nimbus subsystems. The power supply was designed as a separate unit to allow for flexibility and interchangeability. Necessary ground-support equipment developed concurrently with the power supply subsystem is also discussed. N.E.A.

N63-18615 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS COMMAND SUBSYSTEM
D. W. Gade, R. E. Trousdale, F. Wiley (Calif. Computer Products, Inc.), J. Bunn (RCA), and J. J. Over *In its* Proc. of the Nimbus Program Review [1962] 19 p (See N63-18601 17-32)
(Paper 14)

This paper describes the integrated command and clock subsystem, which includes the command-clock and clock-receiver modules in the spacecraft, plus the associated command ground station of the Nimbus spacecraft. The command clock has two major functions: timing and command. The command clock receiver amplifies, demodulates, and processes coded signals from ground-based stations for subsequent input to the command-clock subsystem. From the earth-based command-clock ground station, encoded command messages are transformed into frequency-shift-key signals on the three FM subcarriers in the modulator bay, for transmission to the satellite by means of the command transmitter. N.E.A.

N63-18616 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS TELEMETRY
F. L. Adkins, C. E. Griffin (Radiation, Inc.) and R. Golden *In its* Proc. of the Nimbus Program Review [1962] 19 p (See N63-18601 17-32)
(Paper 15)

The purpose of the Nimbus pulse-code-modulated (PCM) telemetry subsystem is to gather, store, and transmit to ground stations the engineering information needed to evaluate the detail performance, environmental conditions, and general function of all spacecraft subsystems. In addition, the Nimbus PCM telemetry subsystem provides all altitude information needed to determine the exact location of meteorological pictures. The Nimbus spacecraft will carry two electrically independent PCM units: unit A handles 544 channels, which it continually records on tape for readout command; unit B delivers

128 channels by direct transmission. Both units are controlled by signals from the Nimbus clock subsystem. The Nimbus PCM ground station has been designed to accept all video outputs of the PCM telemetry receiver and to process, record, and display the PCM telemetry data received from the satellite. N.E.A.

N63-18617 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS RADIOMETRY
I. L. Goldberg *In its* Proc. of the Nimbus Program Review [1962] 15 p (See N63-18601 17-32)
(Paper 16)

Developmental progress and problems arising from equipment testing are reported for two radiometers, the medium-resolution infrared radiometer (MRIR) and the high-resolution infrared radiometer (HRIR), that have been designed for Nimbus. The MRIR radiometer measures emitted infrared and reflected solar radiation in five spectral regions, using thermistorbolometer detectors. The single-channel HRIR radiometer will be used to map nighttime cloud cover and cloud-top temperatures, or height. Scanning is accomplished similarly in both radiometers; they scan the surface of the earth in strips perpendicular to the orbital track. Tests of both the MRIR and the HRIR will be made both in balloon and aircraft flights, in order to evaluate the performance of the instruments and to aid in the interpretation of the data. N.E.A.

N63-18618 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS ADVANCED VIDICON CAMERA SUBSYSTEM
J. E. Keigler (RCA), G. L. Burdett, and R. Shapiro *In its* Proc. of the Program Review [1962] 23 p (See N63-18601 17-32)

This review of the Nimbus advance vidicon camera subsystem (AVCS) describes: (1) detailed characteristics of the AVCS camera; (2) characteristics of the AVCS vidicon; (3) characteristics of the prototype AVCS; (4) AVCS television camera coverage; (5) the AVCS prototype No. 2 in its final stage of testing; (6) Nimbus AVCS spaceborne equipment; (7) arrangement of Nimbus cameras; (8) Nimbus vidicon tube; (9) Nimbus AVCS tape transport; (10) operation of AVCS during orbiting of Nimbus spacecraft; (11) Nimbus AVCS and HRIR ground-support equipment; (12) Nimbus AVCS kinescope; (13) Nimbus ground-station equipment; (14) Nimbus resolution tests; and (15) test photographs taken by Nimbus AVCS prototype No. 2, camera No. 1. N.E.A.

N63-18619 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AUTOMATIC PICTURE TRANSMISSION SYSTEM
P. H. Werenfels, L. G. Saxton, M. Shepetin (RCA), T. F. Maher, P. Metzner (Fairchild Stratos Electron Sys. Div.), and C. M. Hunter *In its* Proc. of the Nimbus Program Review [1962] 19 p (See N63-18601 17-32)
(Paper 18)

The Automatic Picture Transmission System (APTS) is composed of two subsystems: a satellite camera and a transmission subsystem, and a ground-station receiving and recording subsystem. The satellite camera and transmission subsystem is a storage vidicon system capable of long-duration storage and a very low readout rate. It takes wide-angle pictures from a satellite and transmits them in real time on a very narrow information bandwidth to the ground station for recording on facsimile equipment. The ground-station receiving and recording subsystem consists of an antenna receiver, and facsimile equipment. Principles of operation are described for both subsystems of APTS. N.E.A.

N63-18620 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ENGINEERING APPLICATIONS OF THE NIMBUS TELEMETRY
M. Schmitt, R. Cox (GE), and D. Beiber *In its* Proc. of the Nimbus Program Review [1962] 17 p (See N63-18601 17-32)
(Paper 19)

The role of telemetry in the overall Nimbus spacecraft design, evaluation, and operational effort is described. Discussed are "A" and "B" directories of the Nimbus spacecraft subsystem measured functions and the sampling rate for each function. Also discussed are vacuum-chamber testing of the Nimbus spacecraft, solar-power telemetry, temperature study, altitude calculation of the satellite, and telemetry logic, including S-band transmitter, and grid drive. N.E.A.

N63-18621 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS COMPUTER SYSTEM DESIGN
H. G. Klose, F. E. Lilley (GE), and L. H. Byrne *In its* Proc. of the Nimbus Program Review [1962] 23 p (See N63-18601 17-32)
(Paper 20)

The purpose of this report is to explain in general terms the function of the Control Data Corporation (CDC) 160A computer as part of the fixed ground-station system for Nimbus spacecraft integration and test procedures. The function of the computer is to perform the required computations, logic, formats, routing, and display of reduced results, so that Nimbus project personnel may know the "state vector" of the satellite and all of its subsystems during environmental tests. Described are: (1) computer system configuration; (2) computer input circuitry CDC-160A interface; (3) real-time "A" data input format; (4) computer program description; (5) output format and interpretation of output; and (6) extension of integration programs to operational programs for Alaskan CDC station. N.E.A.

N63-18622 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NIMBUS INTEGRATION AND TEST PROGRAM PLAN
J. F. Mc Guckin (GE), and J. V. Michaels *In its* Proc. of the Nimbus Program Review [1962] 20 p (See N63-18601 17-32)
(Paper 21)

The program plan for the integration and test portion of the Nimbus program at General Electric Company is described. N.E.A.

N63-18629 Plasmadyne Corp., Santa Ana, Calif.
STANDARDIZED RE-ENTRY MATERIALS EVALUATION PROGRAMS
Shirley L. Grindle Mar. 9, 1962 17 p 1 ref
(PLR-117)

The need for standardizing both screening and final evaluation tests of reentry materials is emphasized. In order to facilitate the standardization of such tests, it is proposed that all plasma arc facilities involved in reentry simulation tests be required to satisfy the following: (1) low contamination levels of 0.1%, obtainable with hyperthermal plasma arc facilities using water-cooled metal electrodes; (2) attainment of suitable simulation capabilities compatible with the altitude–velocity requirements for reentry vehicles; (3) calibration of test environment for verification of the simulation attained; (4) uniform flow areas to avoid strong gradients caused by shock waves or pressure gradients present in supersonic flow. A number of measurements and calculations have been formulated which

are considered essential for realistic evaluation of the performance of each material. For the two types of tests considered, certain basic measurements are required for screening purposes; more detailed coverage, involving many more measurements and interpretations of results, is required for final evaluation tests. Those factors considered essential are: (1) weight loss, (2) instantaneous and overall ablation rates, (3) surface temperatures, (4) internal temperatures (including backface); (5) char layer characteristics; and (6) heat balance on model—radiative and convective heat-transfer rates. N.E.A.

N63-18772 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE LANDING CHARACTERISTICS OF A REENTRY VEHICLE HAVING A CANTED MULTIPLE-AIR-BAG LOAD-ALLEVIATION SYSTEM
Sandy M. Stubbs and John R. Mc Gehee Washington, NASA, Aug. 1963 20 p 4 refs
(NASA TN-D-1934) OTS: $0.50

An investigation has been made to determine the landing-impact characteristics of a reentry vehicle having a multiple-air-bag load-alleviation system. A 1/16-scale dynamic model having four canted air bags was tested at flight-path angles of 90° (vertical), 45°, and 27° for a parachute or paraglider vertical letdown velocity of 30 feet per second (full scale). Landing for an attitude range between −15° and 12° gave peak accelerations from 6g to 10.5g units, and maximum onset rates to peak accelerations of 66g per second or less. For landings made at high positive attitudes (15° and 20°), bottoming occurred, and peak normal accelerations were 12 to 15g units. Horizontal velocity had little effect on landing accelerations. The landing behavior was satisfactory for all conditions tested. The canted bags were effective in overcoming the effect of the friction forces resulting from horizontal velocity. Good agreement was obtained between experimental and computed time-history acceleration curves for the 90° flight path, 0° attitude test condition. Author

31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes: boosters; clustered rockets; and multistage rockets.

For propulsion engines see: 27 Propulsion.

For launch vehicle - spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-18216 Hughes Aircraft Co., El Segundo, Calif.
FEASIBILITY OF LARGE LAUNCH VEHICLE RECOVERY
S. A. Milliken N.Y., AIAA [1963] 23 p 7 refs Presented at the AIAA Summer Meeting, Los Angeles, June 17–20, 1963
(Sponsored by NASA)
(AIAA Paper 63-247) AIAA: $0.50 members, $1.00 nonmembers

The feasibility of large launch vehicle recovery is discussed. Launch vehicle design considerations examined include: safety, separation, atmospheric entry, terminal deceleration, water entry, retrieval, and refurbishment for reuse. J.A.J.

N63-18434 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
SPACE ROCKETS AND CARRIER ROCKETS FOR ARTIFICIAL SATELLITES EJECTION INTO ORBIT
In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 41–53 (See N63-18430 17-32)

A review is made of the spacecraft that can be used to eject artificial satellites into orbit. The spacecraft considered include the multistage liquid-propellant rockets, nuclear rockets, electro-reaction rockets, and ion rockets. The basic advantage of nuclear-powered spacecraft over chemical-fuel rockets is the possibility of producing higher jet velocities (specific thrust). The basic advantage of spacecraft with electro-reaction engines is the more favorable ratio of payload weight to initial weight. J.R.C.

32 SPACE VEHICLES (SPACECRAFT)

Includes: manned space capsules; satellites; and space probes.

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For Launch vehicle—spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-18253 Illinois Inst. of Tech., Chicago
THE THEORY OF ROTATIONALLY SYMMETRIC PLASTIC SHELLS
Philip G. Hodge, Jr. Apr. 1963 50 p 31 refs Presented at Symp. on Non-Classical Shell Problems, Warsaw, Poland, Sept. 2–5, 1963
(Contract Nonr-140604)
(DOMIIT-1-23)

The defining equations for a rigid, perfectly-plastic shell are derived from basic principles. On the basis of a single geometric assumption for the velocity field, generalized strain rates and stresses are defined and equilibrium relations deduced. Shell yield conditions and the flow law are discussed in general terms and specifically for piecewise linear yield conditions. The theory of beams under bending and axial forces is discussed to give a general insight into plastic structural behavior. An application to cylindrical shells is given. Author

N63-18255 Philco Corp. Western Development Labs., Palo Alto, Calif.
IMCC SYSTEMS AND PERFORMANCE REQUIREMENTS SPECIFICATION Technical Report
R. S. Cronhardt and D. A. Linden Sept. 7, 1963 330 p 4 refs
(NASA Contract NAS9-366)
(NASA CR-50436; WDL-TR-E120) OTS: $19.75, $10.10 mf

Preliminary system and subsystem requirements and specifications for the Integrated Mission Control Center (IMCC) in support of the rendezvous phases of Project Gemini and Project Apollo are presented. These performance requirements specifications reflect a maximum integration of the IMCC equipment in support of both Gemini and Apollo. This report considers the display console, data processing, operational simulation, and training in GOSS (ground operational support system) interface and communication requirements. N.E.A.

N63-18412 Philco Corp. Western Development Labs., Palo Alto, Calif.
INFORMATION FLOW PLAN DEVELOPMENT (MANNED APOLLO MISSION)

R. S. Cronhardt Aug. 21, 1962 203 p
(NASA Contract NAS9-366)
(NASA CR-50424; WDL-TR-E121) OTS: $14.00 ph, $6.29 mf

A preliminary issue of a series of reports is presented on the development of an information flow plan for the ground operational support system (GOSS) in the manned Apollo missions. This report deals with the Apollo lunar flights and contains mainly background and input information to the development of an information flow plan. Quantitative aspects, such as information bit rates, bandwidths, and accuracies are considered. P.V.E.

N63-18413 Philco Corp. Western Development Labs., Palo Alto, Calif.
INFORMATION FLOW PLAN (GEMINI RENDEZVOUS OPERATION) Preliminary Issue
R. S. Cronhardt July 9, 1962 238 p
(NASA Contract NAS9-366)
(NASA CR-50458; WDL-TR-E114-2) OTS: $15.50 ph, $7.34 mf

Concepts of operations, information flow requirements, and planning for the Gemini rendezvous missions are presented. General guidelines for operational and ground support rules are outlined. Aspects of the manning concept are discussed and tentative recommendations are made. J.A.J.

N63-18423 National Aeronautics and Space Administration, Washington, D.C.
PROJECT SYNCOM
Washington, GPO, 1963 8 p
(NASA FACTS C-5-63) GPO: $0.15

The Syncom Project (synchronous communications satellite) could lead to a global communications network using as few as three repeater satellites. It is possible for four continents to be linked by a single synchronous satellite at 22,300 miles having a circular orbit in the same plane as the earth's equator. J.A.J.

N63-18430 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
SOVIET SATELLITES AND SPACE SHIPS (SELECTED ARTICLES)
S. G. Aleksandrov and R. Ye Federov Feb. 23, 1962 269 p 154 refs Transl. from the book "Sovetskiye Sputniki I Kosmicheskiye Korabli" Moscow, Akad. Nauk SSSR, 1961, 2nd Ed. p 24–82, 117–124, 144–147, 182–184, 217–242, 256–394, 427–456
(FTD-TT-62-121/1+2)

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32. TRAINING OF COSMONAUTS p 236–241 (See N63-18453 17-14)

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N63-18435 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
THE PROBLEM OF DESCENT TO THE SURFACE OF THE EARTH AND PLANETS

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 54–63 (See N63-18430 17-32)

A study is made of the descent of a spacecraft to the surface of the earth and planets. Two methods of decelerating spacecraft during descent which differ in principle are presently feasible. The first of these is based on the use of a reactive force; the second, on the use of aerodynamic forces arising during motion of the spacecraft in an atmosphere. To accomplish the first method of descent, the spacecraft must be provided with a powerplant and a fuel supply to decelerate the spacecraft. With the second method of descent, deceleration of the spacecraft by aerodynamic forces is accomplished most favorably under the condition that the spacecraft is preliminarily converted into an artificial satellite moving to a sufficiently low orbit that is close to circular. J.R.C.

N63-18436 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

ARTIFICIAL SATELLITES AND THE PROBLEMS OF INTERPLANETARY FLIGHTS

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 64–72 (See N63-18430 17-32)

The steps for accomplishing the interplanetary flights with the use of artificial satellites are explored. The basic stages by which mankind will accomplish flights to other celestial bodies include: (1) preparatory research of the basic problems of spaceflight with automatic artificial satellites of the earth; (2) the creation of artificial satellites of the earth with people on them and permanent artificial-satellite stations; (3) the accomplishment by man of flights to the moon and nearby planets without landing on their surfaces; and (4) study of the different planets of the solar system by the organization of expeditions to them. J.R.C.

N63-18439 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

SECOND SOVIET COSMIC ROCKET. FIRST FLIGHT TO THE MOON

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 80–101 (See N63-18430 17-32)

The launching of the Soviet cosmic rocket to the moon was carried out on September 12, 1959. The purpose of the launching was the investigation of cosmic space and the realization of the first flight to the moon. Instrumentation was carried to investigate the following: the magnetic fields of the earth and moon; radiation band around the earth; intensity and cosmic radiation intensity variations; heavy particles in cosmic radiation; gaseous component of interplanetary matter; and meteoric particles. J.R.C.

N63-18449 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

CHAPTER VI. SOVIET COSMIC SHIPS-SATELLITES. FIRST SOVIET SHIP-SATELLITE

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 179–182 (See N63-18430 17-32)

The first Soviet ship-satellite was launched May 15, 1960. The launching was carried out for the purpose of finishing and testing the basic systems of a cosmic ship, and guaranteeing its flight and return to earth. Total weight of the ship-satellite after separation from the last stage of the carrier rocket was 4540 kg. The initial value of orbital perigee altitude was 312 km, and the altitude of apogee was 369 km. The initial period of the ship's round trip in orbit was 91.2 min, at 65° orbital inclination. The results of the launching indicated that the powerful carrier rocket performed with high accuracy according to a given program; in the process of flying, reliability control of the ship-satellite and its orientation was carried out; during the entire flight, the air-conditioning and temperature-control systems functioned normally and radio transmission of commands to the ship, for controlling its orbit and telemetering information, performed successfully; the auto-orientation of the solar battery on the cosmic ship was checked for the first time; telegraphic communication was normal; but telephone communication encountered too much noise interference with great distortions. N.E.A.

N63-18450 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

SECOND SOVIET SHIP-SATELLITE

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 183–184 (See N63-18430 17-32)

The U.S.S.R. launched a second cosmic ship into an earth orbit on August 19, 1960. The ship was lifted into orbit with a perigee of 306 km and apogee of 339 km. The initial period of the ship's rotation was 90.7 min., inclination of orbit to plane of equator was 64° 57'. The basic purpose of launching the ship-satellite was to further development of systems, guaranteeing the life activity of a person, as well as the safety of his flight and return to earth. Numerous medical-biological experiments were carried out during the flight, and scientific investigations of cosmic space were realized. The problems of control flight of the ship and its descent to earth with greater accuracy at fixed points; conditions for normal active life of living substances in cosmic flight; reliable radio and TV communication with cosmic ship have all been solved successfully. Having completed the orbital flight, the cosmic ship, together with its passengers (dogs) and other living substances, has returned safely to earth. Discussed in great detail are (1) arrangement of ship-satellite and (2) flight of the ship and its return to earth. N.E.A.

N63-18451 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

CHAPTER VII. MAN'S FIRST FLIGHT INTO COSMIC SPACE

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 224–233 (See N63-18430 17-32)

On April 12, 1961, the U.S.S.R. realized the first flight of man into cosmic space. The cosmic ship "VOSTOK" with Soviet pilot-cosmonaut Yu. A. Gagarin on board was shot up into an earth orbit. Weight of ship-satellite less the last stage of carried rocket was 4725 kg; altitude of the orbital perigee, 181 km; altitude of apogee, 327 km; orbital inclination, 64° 57'. The carrier-rocket had six powerplants with a total output of 20 million hp. The rocket took off from the BAYKONUR cosmobrome. Having completed its orbital flight, the ship-satellite landed safely in the region of the village Smelovka in the Ternovsk region of Saratov. The arrangement of the cosmic ship VOSTOK is discussed in detail. N.E.A.

N63-18455 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

BIBLIOGRAPHY

In its Soviet Satellites and Space Ships (Selected Articles) Feb. 23, 1962 p 250–268 154 refs (See N63-18430 17-32)

This bibliography contains a list of selected articles summarizing Soviet artificial satellites and manned and unmanned space ships. Included are articles reviewing Soviet satellite observations, measurements, and photography of radiation

intensity and density; particle impact and damage to materials, interplanetary gases; and magnetism in the upper atmosphere. Also included are articles of medical-biological experiments and investigations designed to determine the effect of space-flight conditions on the health of humans. N.E.A.

N63-18656 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EXPERIENCE IN THERMAL-VACUUM TESTING EARTH SATELLITES AT GODDARD SPACE FLIGHT CENTER
A. R. Timmins and K. L. Rosette Washington, NASA, Aug. 1963 15 p 2 refs
(NASA TN D-1748) OTS: $0.50

The philosophy used for conducting thermal-vacuum tests of unmanned earth satellites is presented. The application of the philosophy is examined through the results of the thermal-vacuum tests of three unmanned spacecraft. These results are summarized and discussed with respect to prototype and flight-unit spacecraft, hot and cold environments, and kinds and frequency of failures. Brief commentaries on the space performance of the spacecraft are included. Author

N63-18664 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE PURPOSES OF ENVIRONMENTAL TESTING FOR SCIENTIFIC SATELLITES
John H. Boeckel Washington, NASA, July 1963 27 p 15 refs
Presented to American Soc. for Quality Control (Washington Section) Reliability Training Program, Feb. 12, 1963
(NASA TN D-1900) OTS: $0.75

The economic necessity of high reliability dictates a major role for environmental testing in the exploration of space. High reliability in spacecraft can be achieved only through extensive environmental testing. Successful testing depends on a comprehensive test plan that is formulated from the requirements of specific programs. Successful satellites and space probes can be achieved most economically by full use of such test programs, and by timely application of object lessons learned from previous programs. Author

33 STRESSES AND LOADS

Includes: fatigue; vibration; flutter; and structural tests.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 34 Structural Design.

N63-18218 North Carolina State Coll. School of Physical and Applied Mathematics, Raleigh
THE EFFECT ON INTERNAL CRACKS ON THE DISTRIBUTION OF STRESS IN THIN ELASTIC STRIPS AND CYLINDERS
Ian N. Sneddon (Glasgow U.) July 28, 1963 81 p 20 refs
(Grant AF-AFOSR-444-63)

The effect of internal cracks on the distribution of stress in thin elastic strips and cylinders is analyzed. Solutions are presented for the distribution of stress in a strip of finite width containing a Griffith crack and for the distribution of stress in a cylinder containing a penny-shaped crack. B.J.C.

N63-18226 New York U. Coll. of Engineering, N.Y.
STRESSES AT RING STIFFENED INTERSECTION OF CYLINDER AND REDUCING CONE Technical Report
Herbert Becker and Gerald Gurtman Aug. 1962 27 p 9 refs
(Contract NObs-78787)
(SM 62-8)

By means of axisymmetric theory and two-dimensional photoelasticity, the stresses in a prototype ring-stiffened cone-cylinder intersection were investigated for a range of fillet radii. Peak stress concentrations for the various models were found to be between 1.00 and 1.78, for fillet radii between 0.500 inches and 0.062 inches. Results reported in the literature showed good agreement of two- and three-dimensional stress ratios for symmetric bending and tensile specimens. Furthermore, good correlation was obtained between the stress ratios reported for asymmetric specimens investigated in the present study and for symmetric two-dimensional specimens reported in the literature. Author

N63-18284 Johns Hopkins U., Baltimore, Md.
ENERGY BALANCE IN HYPERVELOCITY PENETRATION
C. M. Glass (Aberdeen Proving Ground), R. B. Pond, and C. Mobley May 1, 1963 18 p 3 refs

A technique for developing a balance between the kinetic energy of the pellet and the dynamic energy absorbed by the target is demonstrated. A proposed dynamic stress–strain diagram is used to develop the mechanical energy equivalent as a function of strain. The strain gradient under the crater is developed by a delineation of grain size after annealing the target as well as an extended tapered tensile specimen. The technique shows the kinetic energy to be absorbed by five processes: i.e., pellet disintegration, crater lip formation, crater disintegration, development of a high shear strain volume, and development of a low shear strain in the rest of the target. After a determination of the geometry of the fields in the last four processes and the strain gradients therein imposed, the mechanical energy equivalent is applied to show the energy balance. Author

N63-18285 Florida U. Engineering and Industrial Experiment Station, Gainesville
ELASTIC INSTABILITY OF PRESSURIZED CYLINDRICAL SHELLS UNDER COMPRESSION OR BENDING
S. Y. Lu and W. A. Nash June 1963 10 p 9 refs Repr. from Proc. Fourth U. S. Natl. Cong. Appl. Mech., Calif., U., June 18–21, 1962, v. 1 p 697–704
(NASA Grant NsG-16-59)
(NASA CR-50207; *Its* Eng. Progr. Univ. Florida, vol. 17, no. 6, Tech. Paper 263)

The elastic stability of circular cylindrical shells subject to either axial compression or pure bending is investigated for the case of cylinders strengthened by internal pressure. Nonlinear finite deflection theory is employed, and an approximate solution of the equilibrium and compatibility equations is obtained by use of Galerkin's method. Comparatively simple expressions are presented for the various buckling stresses; these expressions are evaluated to yield buckling stresses as a function of the internal pressure. The critical stress for bending is found to be greater than that in axial compression, and in approximately the ratio indicated by recent experimental evidence. Author

N63-18308 Avco Corp. Research and Advanced Development Div., Wilmington, Mass.
RELIABILITY PHYSICS (THE PHYSICS OF FAILURE)
D. R. Earles and M. F. Eddins Mar. 1962 33 p 8 refs
(*Its* Reliability Eng. Data Ser.)

The physics of failure covers five basic areas: (1) failure criteria, (2) failure mechanisms, (3) failure modes, (4) failure stresses, and (5) failure rates. Theory and postulates governing the physics of failure rate and failure rate correlations are discussed. N.E.A.

N63-18307 Avco. Corp. Research and Advanced Development Div., Wilmington, Mass.
FAILURE RATES
D. R. Earles and M. F. Eddins Apr. 1962 105 p 225 refs (*Its* Reliability Eng. Data Ser.)

Failure rates, as applied to reliability engineering, are discussed in the following: (1) failure frequency function, (2) failure-rate standards, (3) chronology of failure-rate development, (4) failure-rate normalization, (5) definitions of some applicable quantitative failure-rate measurements, (6) standard installation environments, (7) failure-rate data analysis, (8) failure-rate modifiers, (9) life-expectancy data analysis, (10) life-expectancy modifiers, (11) failure-rate application factors, (12) failure-rate life expectancies, (13) failure therblig definition, (14) therbligs, (15) human therbligs, (16) equipment therbligs, (17) failure therbligs, (18) failure-therblig failure-rate development, (19) failure-therblig failure-rate mathematical model, and (20) failure-therblig application. N.E.A.

N63-18308 Avco Corp. Research and Advanced Development Div., Wilmington, Mass.
FAILURE MECHANISMS
D. R. Earles and M. F. Eddins Apr. 1962 37 p 17 refs (*Its* Reliability Eng. Data Ser.)

This handbook of failure mechanisms covers the concept of physical- and chemical-energy storage mechanisms, cycling, and the dynamic versus the static state. P.V.E.

N63-18309 Avco Corp. Research and Advanced Development Div., Wilmington, Mass.
FAILURE CRITERIA
D. R. Earles and M. F. Eddins May 1962 21 p 4 refs (*Its* Reliability Eng. Data Ser.)

Failure criteria as applied to reliability is discussed for the following: (1) input and output (equipment), (2) stress levels, (3) strength–stress criteria, (4) strength criteria tests, (5) structural failure criteria considerations, (6) electrical-strength failure criteria, (7) operating parameter failure criteria, (8) environmental-strength failure criteria, (9) procedures for estimating failure criterion, (10) failure probability criteria, (11) systems failure criteria, and (12) failure criteria specifications. N.E.A.

N63-18337 Stanford U., Calif.
BASIC CONCEPTS OF ELASTIC STABILITY
J. M. Thompson Feb. 1963 62 p 20 refs
(NASA Grant NsG-93-60)
(NASA CR-50502; SUDAER-146) OTS: $6.60 ph, $2.06 mf

The buckling and snapping behavior of an elastic structure subjected to a single generalized load is discussed, the analysis being based on a more general study of elastic stability recently presented by the author. The discussion is orientated to highlight the more physical and intuitive aspects of elastic stability, and examples of the various phenomena are indicated. The examples include problems of shell buckling that are of considerable interest at the present time. Author

N63-18461 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A STATISTICAL MODEL FOR SYNTHETIC WIND PROFILES FOR AEROSPACE VEHICLE DESIGN AND LAUNCHING CRITERIA
Robert M. Henry Washington, NASA, July 1963 36 p 24 refs (NASA TN D-1813)

A model for extreme-value wind-velocity profiles, based on the multivariate gaussian (joint normal) distribution of the horizontal components of wind velocity, is presented. These profiles can be constructed rapidly and objectively wherever the parameters of the wind distribution are known, and they can be tailored to a specific location, season, launch azimuth, and critical altitude. Some examples of these profiles are shown and discussed. In addition to the usual design-criterion profile, methods of constructing extreme-value profiles for launching criteria are presented, and the application of these profiles in aerospace-vehicle operations is indicated. Derivation of the equations used to construct the profiles, and derivation and discussion of confidence limits are presented in appendixes. Author

N63-18626 Boeing Co., Seattle, Wash.
AN APPROACH TO THE PREDICTION OF PRESSURE VESSEL MINIMUM FATIGUE LIFE BASED UPON APPLIED FRACTURE MECHANICS
C. F. Tiffany and F. A. Pall Mar. 1963 36 p 15 refs
(D2-22437)

A practical approach to the prediction of minimum pressure-vessel fatigue life is presented. The approach is based upon the fact that small surface or internal flaws usually are present in pressure vessels, and with multiple stress cycles, they grow to critical size (size required for instability), and failure results. The approach is considered to be primarily applicable to high pressure tanks with relatively thick walls, where the flaw can reach instability in plane strain prior to growing through the thickness. For thin walled low pressure tanks a subcritical surface or internal flaw will likely grow through the thickness and result in tank leakage, unless, as a result of high heat treat strength level and/or extremely low operating temperatures the material is in a relatively brittle condition. Critical flaw sizes have been observed at the failure origins of both steel and aluminum tanks and are compared with those predicted using the plane strain critical stress intensity values obtained from round notch bar tests, the calculated tank stresses, and the maximum crack edge stress intensity equation for elliptical cracks as developed by Irwin. The usefulness of the stress intensity concept in relating round notch bar fatigue test data to the cyclic flaw growth in pressure vessels is shown and verified experimentally with precracked plate and tank component fatigue tests. Predicted cyclic flaw growth curves, as derived from round notch bar fatigue tests, for an aluminum alloy at room and cryogenic temperatures and for a steel alloy at room temperature are included. Author

N63-18668 National Aeronautics and Space Administration, Washington, D.C.
THE EFFECT OF INITIAL IMPERFECTIONS ON THE BUCKLING STRESS OF CYLINDRICAL SHELLS
C. D. Babcock and E. E. Sechler (Calif. Inst. of Tech.) July 1963 46 p 7 refs Previously processed; for abstract see N63-10817 02-33
(NASA Grant NsG-18-59)
(NASA TN-D-2005) OTS: $1.25

An experimental investigation is carried out to determine the effect of an axially symmetric initial imperfection on the buckling load of a circular cylindrical shell under axial compression loading. The imperfection studied has the form of a half sine wave in the length direction. The shells are formed by a copper electroforming process. The theoretical buckling loads are also computed for the imperfect shells, and show the same trend as the experimental study. Author

N63-18721 Belfour Engineering Co. Technical Information Systems Div., Suttons Bay, Mich.
FATIGUE OF METALS – ALUMINUM, SECTION II
May 1962 35 p 15 refs
(Contract AF 33(616)-7238)
(ASD-TN-61-117, Pt. IV; AD-278355)

The graphs presented display metal-fatigue information from various sources of published and unpublished test reports, which have been processed and regenerated through a semi-automatic data-processing system. Each series or set of graphs contains descriptive information (legends) which identifies the material, test procedure, test conditions, and the most significant test and/or material variables associated with the plotted data. The data displayed in each set of graphs are intended to answer very general "questions", and to serve as a guide to further investigation of specific areas within the subject presented. Author

N63-18723 Advisory Group for Aeronautical Research and Development, Paris (France)
CYCLIC TEMPERATURE EFFECTS ON MATERIALS AND STRUCTURES
J. A. Dunsby July 1962 30 p 55 refs
(AGARD-410)

A review is made of the present state of knowledge on cyclic temperature effects on materials and structures. Suggestions are made for further research. Author

N63-18771 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE EFFECTS OF VARIABLE-AMPLITUDE LOADINGS ON FATIGUE CRACK PROPAGATION PATTERNS
C. Michael Hudson and Herbert F. Hadrath Washington, NASA, Aug. 1963 23 p 4 refs
(NASA TN D-1803) OTS: $0.75

Axial-load variable-amplitude fatigue tests were conducted on 2024-T4 aluminum-alloy specimens. Both gust and ground-air-ground cycles were simulated in these tests, and the resulting fracture patterns were carefully inspected to determine which loadings produced the various markings. The effects of loading order and load magnitude on the size and texture of the markings were also investigated. Author

34 STRUCTURAL DESIGN

Includes: structural elements; and weight analysis.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

N63-18349 Brown U. Div. of Applied Mathematics, Providence, R.I.
MINIMUM-WEIGHT DESIGN OF BEAMS SUBJECTED TO FIXED AND MOVING LOADS
M. Save and W. Prager Feb. 1963 23 p 7 refs
(Contract Nonr-562(10))
(Tech. Rept. 86; C11-86)

The paper is concerned with minimum-weight design of statically indeterminate beams that are subjected to a system of fixed loads and a single moving load. When all loads have the same direction, the minimum-weight design of a beam, with a single span for combined action of fixed and moving loads, may be obtained by superposition of the minimum-weight designs corresponding to separate action of the individual loads. This superposition principle is not generally valid for continuous beams, though it may be useful in special cases. Author

N63-18372 Brown Engineering Co., Inc., Huntsville, Ala.
ANALYSIS OF THE TSIEN NOZZLE
C. C. Lee Feb. 1963 28 p 2 refs
(NASA Contract NAS8-2485)
(NASA CR-50411; Tech. Note R-30) OTS: $2.60 ph, $1.04 mf

A numerical method for designing a converging nozzle is presented. Since the calculations are tedious, an IBM-1401 FORTRAN program was developed and is included in the appendix. A relation for the thrust coefficient in a converging nozzle is also derived for isentropic flow. As an example of the application of the numerical method, the analysis of a specific Tsien nozzle is included. Author

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